POPULAR

ASTRONOMY

A REVIEW OF ASTRONOMY AND ALLIED SCIENCES

Founded by W. W. Payne

CURVIN H. GINGRICH
Editor

DECEMBER 1940

PUBLISHED MONTHLY
(Except July and September)

BY GOODSELL OBSERVATORY OF CARLETON COLLEGE

Northfield, Minnesota, U. S. A.

20-inch Double Astrographic Camera
for Lick Observatory

Designed and Constructed by

THE WARNER & SWASEY COMPANY
CLEVELAND, OHIO

Our Galaxy as seen from Distant Points

By ALBERT G. MOWBRAY

It is sometimes of interest to make an attempt to "see ourselves as others see us," and while it is not possible to leave the earth and the Galactic system, and view our stellar system from the outside, it is possible to calculate what its appearance would be in such a view. In this paper an attempt is made to determine how it would look to an imaginary observer viewing it from the Magellanic Clouds, from the great Andromeda Nebula, or from the Virgo cluster of galaxies, on the assumption that such an observer had at his disposal instruments such as those we now use. We may then compare our Galaxy with other external galaxies as to size, brightness, prominence of individual objects, and other properties.

The surface luminosity of the Galaxy as seen from a considerable distance should first be investigated. This was determined in 1920 by Seares,[1] using the best data then available; he found that the surface luminosity of the Galaxy near the sun is considerably less than that at the center of other galaxies. A description of the general appearance of the Galaxy is given in a later paper by Seares.[2] He compares a photograph of a portion of the Milky Way with a much enlarged photograph of a portion of the Andromeda Nebula, showing their striking resemblance. A short discussion of the appearance of our Galaxy is also given by Hubble,[3] together with a description of the "local group" of galaxies to which it belongs.

Table I gives a possible assortment of instruments for our hypothetical observer. The limiting magnitudes (for an exposure time of two hours, using Cramer Hi-Speed plates), and the resolving powers, are calculated on the basis of the performance of the Harvard cameras and the 61-inch reflector at Oak Ridge.

TABLE I

INSTRUMENTAL EQUIPMENT.

Instrument	Location	Focal length (inches)	Lim. Mag.	Lim. angle of Res.	Ref.
1½-inch Cooke,	Oak Ridge-Harvard Observatory	14	12	30″	
8-inch Ross,	Oak Ridge-Harvard Observatory	50	17	9	
36-inch Crossley,	Mt. Hamilton-Lick Observatory	212*	20	3	4
100-inch,	Mt. Wilson	500*	22	1	5
		1600†			
200-inch,	Palomar Mountain	660*	23	0.5	6
		3200†			

*Prime Focus.   †Cassegrain Focus.

The appearance of the Galaxy will be studied for an observer in the direction of the galactic pole at three distances: 32,000, 320,000, and 3,200,000 parsecs; or 100,000, 1,000,000, and 10,000,000 light years. The Magellanic Clouds are at about the first distance, 32,000 parsecs; the great Andromeda Nebula (M31) is rather more than 200,000 parsecs distant, or somewhat closer to us than the second assumed distance; and the Virgo cluster is somewhat closer than the third distance. Table II gives the distance moduli (apparent magnitude minus absolute magnitude) and the values of 206,265/ρ (ratio of apparent length in seconds of arc to actual length in parsecs) for these three assumed distances.

TABLE II

DISTANCE MODULI AND 206,265/ρ

Distance (ρ)	Distance Modulus	206,265/ρ
32,000	17.5	6.5
320,000	22.5	0.65
3,200,000	27.5	0.065

Summary of Results: For an observer looking from the Magellanic Clouds, individual stars in the Galactic system could be seen on plates taken with all but the smallest photographic telescopes. Galactic and globular clusters would be prominent, and most galactic clusters would be resolvable with the large reflectors. Variable stars and novae could be studied.

For an observer at the Andromeda Nebula, giant stars, including novae and most of the variables, would be visible on plates taken with the large reflectors. Clusters could be detected with the larger telescopes, but could not be resolved.

From the distance of the Virgo cluster, no individual objects could be seen, although the Galaxy as a whole would have an apparent magnitude of +7.5, and a diameter of half a degree. To nearly this distance, it would be visible to the unaided eye as a hazy patch.

It would be difficult to detect bright diffuse nebulae; but such objects might be noticeable at the closer distances as regions with emission spectra. Dark nebulae would probably be confused with irregularities in stellar distribution. If the Galaxy were viewed from a distant point nearly on its plane, it would probably show considerable dark material along that plane, similar to that shown by some external galaxies.

The Galaxy as a whole would appear to a distant observer as a spiral nebula of a fairly late type, resembling the nebula in Andromeda (M31), or that in Triangulum (M33). It is usually thought to be larger and brighter than most external galaxies, and the absolute magnitude obtained in this paper is indeed very bright; but the value of the surface brightness near the sun is comparable with that of the Andromeda Nebula at half the distance from the center. The total size and brightness of the Galaxy are only inaccurately known, and may actually be near the average for external galaxies.

It is interesting to note that a study of the separation in space of stars of various magnitudes shows that any star bright enough to be visible at all with our present equipment would be sufficiently distant from equally bright neighbors to be easily resolvable. At any rate, this condition exists in the region of the Galaxy near the sun; we cannot tell whether or not it would be true at the center. In this respect our Galaxy near the sun resembles the outer parts of spiral nebulae or globular clusters, rather than the inner parts of globular clusters, where the stars are so closely packed together as to be unresolvable, although bright enough to be observed if they were alone.

Surface Luminosity: Van Rhijn's general luminosity law[7] gives $\phi(M)$, the number of stars per cubic parsec near the sun with absolute magnitudes between $M - \frac{1}{2}$ and $M + \frac{1}{2}$. On multiplying $\phi(M)$ by the effective thickness of the Galaxy, one obtains the number of stars of this absolute magnitude per square parsec, as seen projected on the galactic plane. Table 4 of Bok's "Distribution of the Stars in Space"[8] shows the distance at which the density of stars of absolute magnitude M falls to half its value at the plane; we may take twice this distance as the effective thickness for that absolute magnitude:

Absolute Magnitude:	0	+4	+8
Effective Thickness:	250	350	500

If the number of stars per square parsec (as seen in projection) of each absolute magnitude is multiplied by the luminosity corresponding to that absolute magnitude, and the results summed over all absolute magnitudes, one gets the luminosity of the Galaxy near the sun per square parsec. The result is 33 stars of photographic absolute magnitude +6 per square parsec.

The surface luminosity of the Galaxy in the vicinity of the sun can be found in another way. Oort[9] gives the number of stars of absolute magnitude +6 per cubic parsec giving the same amount of light as is present in the Galaxy, for different distances z from the galactic plane. These values have been plotted against z, and a smooth curve drawn through them. Twice the area beneath this curve represents the surface luminosity of the Galaxy near the sun; the resulting value is 41 stars of absolute magnitude +6 per square parsec.

The mean of these two values for the surface luminosity of the Galaxy near the sun is approximately 40 stars of absolute magnitude +6 per square parsec, or 23.6 magnitudes per square second of arc (mag/‴²).* This value should perhaps be reduced by a few tenths of a magnitude to allow for interstellar absorption. Miss Beecher[10] finds by another method, taking account of absorption in the Galaxy, a surface brightness of 24.0 mag/‴², agreeing well with the value obtained here.

Redman and Shirley[11] have published measurements of the surface

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*Surface luminosity is independent of the distance from which the object is viewed.

luminosity of M31 (Andromeda) and M33 (Triangulum). For M33, it is about 20.8 mag/$'''^2$ at the center; for M31, it is 14.8 mag/$'''^2$ at the center, falling off to 24 mag/$'''^2$ at 87', and 26.7 mag/$'''^2$ at 138' from the center along the major axis. If our Galaxy were seen tilted at the angle at which we see M31, its surface brightness would be increased to about 23 mag/$'''^2$, approximately the same as that of M31 at a point 1°.3 from the center along the major axis. This angle corresponds to a distance from the center of 5,000 parsecs. As the sun is about 10,000 parsecs from the center of our Galactic system, this indicates that the distribution of surface luminosity in our Galaxy may be similar to that in M31.
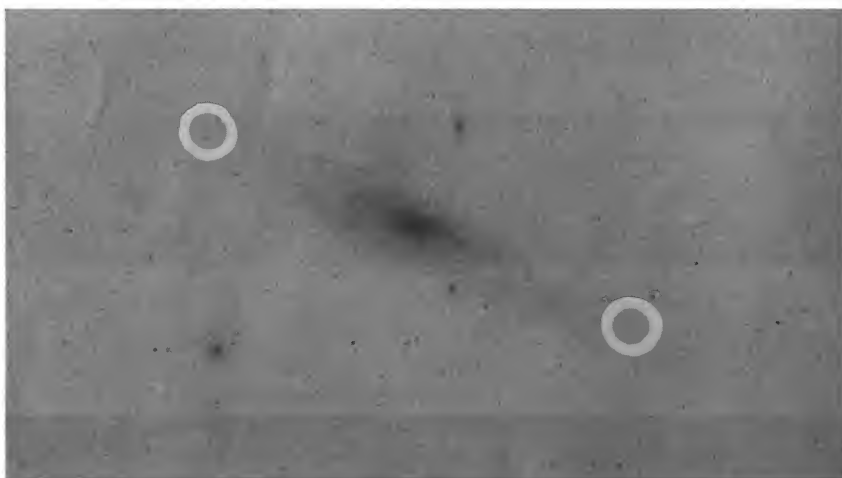
FIGURE 1.

GREAT NEBULA IN ANDROMEDA (M31).

Circles drawn at points on Major axis 1°3 from the center, where the surface luminosity is the same as that in our Galaxy near the sun. (Photograph by courtesy of F. Zwicky, California Institute of Technology; 15-minute exposure, Schmidt Telescope, Palomar Mountain.)

Figure 1 shows a photograph of M31, with circles drawn on the major axis at points 1°.3 from the center. It is to be noted that the visible image of the nebula does not extend so far out, although it can be traced to that distance with the aid of the microsensitometer[11] or the photoelectric cell,[12] or on very long exposure photographs.

Total Luminosity: According to Smart,[13] the total mass of the Galactic system is 2×10^{11} that of the sun. Oort[9] finds that the ratio of mass to luminosity for the region of the Galaxy near the sun is 1.8 times that of the sun. From measures of the amount of light received from the central part of the Galaxy, he finds this ratio to be 12 in the center; but because of obscuration, this value is probably too high. He finds from the work of Slipher and of Pease a ratio 10 for NGC 4594, where absorption is certainly present. Hubble found a ratio 1.3 for the Andro-

meda Nebula. If the ratio 2 holds throughout the Galaxy, its absolute magnitude would be —21.5; if the ratio were 5 or 10, the absolute magnitude would be —20.5 or —19.8. According to Hubble,[14] the absolute magnitudes of most extragalactic nebulae are around —14 or —15; that of the Andromeda Nebula is —17.5. If the value —20 for our Galaxy is correct, it would seem to be exceptionally bright.

The diameter of the Galaxy is approximately 30,000 parsecs, with the sun about 10,000 parsecs from the center. For the three distances, the apparent magnitudes and angular diameters are shown in Table III.

TABLE III

APPARENT MAGNITUDE AND DIMENSIONS OF THE GALAXY.

Distance (parsecs)	Apparent Magnitude	Angular Diameter
32,000	—2.5	.50°
320,000	+2.5	5
3,200,000	+7.5	0.5

From the Magellanic Clouds, the Galaxy would be a huge object, reaching a third of the way across the sky, and probably appearing much as a section of the Milky Way appears to us. From the Andromeda Nebula, it would appear much as that body appears to us, but considerably brighter. From the Virgo Cluster, it would be plainly visible as an extended object on plates of even the smallest cameras.

It would be visible on plates taken with the 200-inch telescope at still more enormous distances. If there were no red shift, or absorption of light in space, the apparent magnitude of the Galaxy would be 22.5—the limit of existing equipment—at a distance of 3,200,000,000 parsecs or 10,000,000,000 light years. The red shift, however, which decreases the apparent brightness of distant nebulae, might make it too faint to be visible at such a distance. Hubble states that the farthest observable nebulae are about 500,000,000 light years distant. As our system is five magnitudes brighter than the average, it should under similar conditions be visible 10 times as far away, or at 5,000,000,000 light years.

Individual Stars: Whether or not individual stars are resolvable is determined by their separation (as seen in projection), from nearby stars that are as bright or brighter. In our determination of the surface luminosity of the Galaxy, we made use of the number of stars per square parsec (as seen in projection) of each absolute magnitude. From these data can be found the average separation of the stars. The solid curve in Figure 2 represents the separation of stars from nearby stars as bright or brighter for different absolute magnitudes. In addition, there are marked on the diagram points representing the absolute magnitude and linear separation corresponding to the limiting apparent magnitude and resolving power of each telescope at each distance.

If these points were above the curve, it would indicate that stars bright enough to appear on the plates would be too close to be resolved, for in approaching fainter magnitudes, the curve would reach the limit-

ing resolution of the camera before the limiting magnitude. But for our present equipment, the points are all below the curve, showing that the limiting magnitude, rather than the resolution, determines which stars shall be visible.
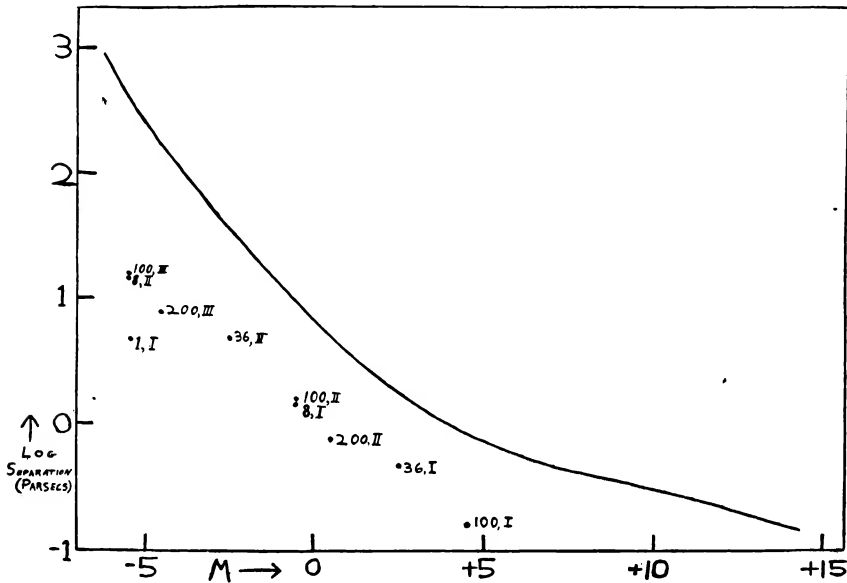

FIGURE 2.

SEPARATION OF STARS FROM NEARBY STARS AS BRIGHT OR BRIGHTER.

Points represent limiting magnitude and resolution of telescopes at various distances; I = 32,000 parsecs, II = 320,000 parsecs, III = 3,200,000 parsecs. "36, II" is the 36-inch telescope at 320,000 parsecs, for instance.

For the central part of a globular cluster, the curve would pass below the plotted points, indicating that stars bright enough to be seen on the plates would not be resolvable. In the outer parts, however, stars are shown individually; there the curve would pass above the plotted points. If a slower, finer grained, emulsion were used, the limiting magnitude of the plates would be decreased, and their resolution improved, thus moving the plotted points downward and to the left; a faster, coarser, emulsion on the other hand would move the points upward and to the right, and would perhaps move them across the curve. However, the present calculations are made on the assumption that Cramer Hi-Speed plates are used, about the fastest available for astronomical work.

Table IV gives the apparent magnitudes of several representative stars at the three distances.[15] The 8-inch camera would show only the brightest giants at the closest distance. All the giants would be visible to the Crossley at the closest distance, and the brightest giants at the Andromeda Nebula. All but the faint dwarfs would be within reach of the 100-inch or 200-inch telescopes at the Magellanic Clouds, as would

the brightest giants at the Andromeda Nebula; but none of these stars would be shown at the Virgo Cluster.

TABLE IV

INDIVIDUAL STARS.

Star	Spectrum	Ptg. Abs. Mag.	— Apparent Magnitudes —		
			32,000	320,000	3,200,000
β Centauri	B1	— 4.1	13.4	18.4	23.4
α Orionis (Betelgeuse)	cM0	— 1.2	16.3	21.3	26.3
α Boötes (Arcturus)	gK0	+ 0.8	18.3	23.3	28.3
α Canis Majoris A (Sirius)	A0	+ 1.3	18.8	23.8	28.8
α Centauri A	dG0	+ 5.3	22.8	27.8	32.8
α Canis Majoris B (White Dwarf)	F	+11.5	29.0	34.0	39.0
Krüger 60 A	dM3	+12.7	30.2	35.2	40.2

Clusters: Galactic clusters[16] have diameters of from 1 to 15 parsecs, averaging perhaps 4; the number of stars is usually between 35 and 200. For 75 stars, and a diameter of 4 parsecs, the average separation as seen projected would be 0.4 parsec. In some clusters, the stars reach photographic absolute magnitude —4, in others only 0. The integrated absolute magnitudes of the clusters range from —2 to —5 or more.

According to Shapley,[17] the diameters of the globular clusters are about 35 parsecs; the absolute magnitude of the brightest stars is about —2, and that of the cluster as a whole —7 or even brighter. The separation of the component stars is so small near the center that no telescope could possibly resolve them, though the outer edges might be resolvable. The data on clusters are collected in Table V.

TABLE V

GALACTIC AND GLOBULAR CLUSTERS.

Distance	32,000	320,000	3,200,000
Galactic Clusters:			
Apparent magnitude of clusters	12-16	17-21	22-26
Apparent magnitude of brightest stars	13-18	18-23	23-28
Diameter of clusters (seconds of arc)	13-52	1.3-5.2	0.13-0.52
Separation of stars (seconds of arc)	3	0.3	0.03
Globular Clusters:			
Apparent magnitude of clusters	10.5	15.5	20.5
Apparent magnitude of brightest stars	15.5	20.5	25.5
Diameters of clusters (seconds of arc)	230	23	2.3

At the distance of the Magellanic Clouds both types of clusters would be visible with the 8-inch camera, but only the galactic clusters could be resolved even with the large reflectors. At the distance of the Andromeda Nebula, the galactic clusters would be visible only with the large reflectors, although globular clusters would be shown by the 8-inch. At the distance of the Virgo cluster of galaxies, the galactic clusters could not be observed, while the globular clusters would still be within reach of the 100-inch and 200-inch reflectors, but would appear only as slightly broadened stars, and their nature would probably not be suspected.

Other Objects: We have few data as to the frequency of supernovae in any one galactic system, but presumably they would be as likely

to occur in ours as in any other, particularly as our system may be larger than the others. They would be plainly shown by all the telescopes except the 1½-inch camera at the greatest distance. At the distance of the Magellanic Clouds, they would be visible to the unaided eye.

TABLE VI

NOVAE, VARIABLE STARS, PLANETARY NEBULAE.

	Ptg. Abs. Mag.	— Apparent Magnitude —		
		32,000	320,000	3,200,000
Supernovae[18]	—13	4.5	9.5	14.5
Novae[18]	— 6	11.5	16.5	21.5
O stars	— 4	13.5	18.5	23.5
Be stars	— 3	14.5	19.5	24.5
Cepheids[18]	0 to —3.5	14-17.5	19-22.5	24-27.5
Red Variables[18] (At maximum)	— 1	16.5	21.5	26.5
Planetary Nebulae[19]	— 1	16.5	21.5	26.5

Ordinary novae could be observed with all the telescopes at the closest distance, and with all but the smallest at the middle distance; but only with the 100-inch or 200-inch at the greatest distance. Fifty or one hundred might occur in a year.

The O and Be stars are the brightest known normal stars; none of them would be shown with the smallest camera. They and the variables and planetaries would be shown by all the other instruments at the Magellanic Clouds, and by the large reflectors at the Andromeda Nebula; but at the Virgo Cluster, none of them would be detected.

The diameter of a planetary nebula may be about 0.16 parsec, corresponding to 1″ at 32,000 parsecs distance. It would in no case show a disc, although on plates taken with the 200-inch telescope at the closest distance, it might be slightly broader than the stellar images. These objects, however, might be recognizable on slitless spectrograms, through their characteristic bright-line spectra.

The surface brightness of a diffuse nebula is the same at any distance. Some of them are extensive enough to show a perceptible area at the farthest distance, even on plates taken with small telescopes. But there would be a background of unresolved faint stars, and it is very doubtful if any diffuse nebula would be recognized as such. Dark nebulae might appear, but it would be impossible to distinguish them from irregularities in the stellar distribution. If the Galaxy were viewed from a point nearly in its plane, it would probably show a distinct dark equatorial band, such as is shown by many external galaxies, caused by general interstellar absorption close to the galactic plane.

The spectrum of the Galaxy near the sun would probably be of about the same type as that of the sun itself, with perhaps stronger hydrogen lines due to the numerous A-type stars. Bright nebulae which show emission line spectra would perhaps be visible on spectrum photographs; similar emission patches have been observed in the Andromeda Nebula.[20] In addition, there may be a line-emission spectrum visible all over the Galaxy. Struve and Elvey[21] have found evidence of hydrogen and ion-

ized oyggen emission in the Milky Way, and feel that on examination from the outside our Galaxy would show these lines, superimposed on the continuous spectrum from the stars. Mayall[22] has found the ionized oxygen line, λ 3727, in about half of the external galaxies examined by him, and the same line might well appear in the spectrum of our own Galaxy.

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Planets and Sun Spots

By WILLIAM A. LUBY

1. *Introduction.* There are two views concerning the origin of sun spots. One as stated by Hale is: "They are deep-seated manifestations of the internal circulation of the sun." The other view is that they are caused by planetary action. Observations tending to show a connection between the planet Mercury and sun spots were begun as early as 1862. Since that time a long list of excellent astronomers have in various ways connected Venus, the earth, and Jupiter with the appearance of sun spots.

A crucial difficulty which no one of these observers overcame was an explanation of how planetary action produces sun spots. It is now universally agreed that tidal action even of Jupiter on the sun is too small. However, precessional action of a planet on the sun is enormously greater than is tidal action and its disturbance of solar equilibrium is correspondingly large. In the August number of the *Astronomical Journal* for 1930, the writer published an article on "The Cause of the Sun's Spots." This was a study of the precessional action of the four major

planets on the sun compared with the yearly area measures for 1826 to 1930 inclusive. The aim of the present paper is to extend the scope of the former one and include the precessional action of the smaller planets Mercury, Venus, and the earth along with that of Jupiter and Saturn.

2. *How the planets may cause sun spots.* There can be no doubt that the equatorial diameter of the sun is greater than the polar. The work of Tisserand and Moulton have established that fact. Moreover, the plane of the sun's equator makes angles with the planes of the planetary orbits which lie within the range 3° to 8°. Precessional action of a planet on the sun disturbs solar equilibrium. This is not merely a theoretical possibility. Precessional action of the moon on the waters of the ocean has actually been observed.

Lieutenant (later Rear-Admiral) J. E. Pillsbury, U.S.N., while attached to the United States Coast and Geodetic Survey, made a four year study of the Gulf Stream. An account of his work was published in the *Report of the Survey* for 1893. He found that twenty-one cubic miles of water flow through the Florida Straits every hour. Moreover, he discovered that twice in every lunar month, at high declination of the moon and at low declination, the character of the flow changes. Pillsbury wrote: "Following the changes in the declination of the moon, the velocity of the stream at a given point is accelerated or diminished, but while it is running faster at one place, at another it is running slower" (page 541).

He devotes many pages to the evidence for this variation and continues: "It seems therefore abundantly proved that this monthly variation in the straits of Florida consists of an expansion at high declination followed by contraction and increased localized speed at low declination" (page 546).

The earth is an ellipsoid whose equatorial belt is only partially liquid. Even so, the effect of precessional action upon the ocean has been observed.

It would follow unavoidably that the planets would exert precessional action on the sun's equatorial belt and *vice versa* the sun would exert precessional action on the gaseous equatorial belts of Jupiter, Saturn, Uranus, and Neptune. Here then is a possible mode of action by which the planets may cause the sun spots.

The other crucial difficulty of a planetary cause for sun spots is that implicitly Jupiter has the dominant role and its period 11.86 years is about 6 per cent greater than the "accepted" mean length of the sun-spot cycle. This difference will be considered in Section 10.

3. *Precessional action.* Precessional action is possible only when the rotating body is an ellipsoid and the plane of its equator is inclined to the plane of the orbit of the companion. Such action tends to bring the plane of the equator into the plane of the orbit of the companion but never does so. The net action may be regarded as a couple. In a rigid

rotating body this produces conical motion of the axis of rotation.

We are not here concerned with this conical motion. Pillsbury's work shows that, aside from the conical motion of the earth's axis, the precessional action of the moon disturbs the equilibrium of the ocean. Consequently, the precessional action of a planet on the sun disturbs the solar equilibrium.

The disturbance of solar equilibrium arises as follows. The precessional couple of the earth on the sun tends to shift material of the solar belt southward toward the equator on one side of the sun and northward toward the equator on the opposite side. The centrifugal force of the sun's rotation tends to maintain the equatorial belt always in the same position. The continuous interaction of these forces produces a continuous disturbance of solar equilibrium. It is the purpose of this paper to show that the joint disturbance mainly of Mercury, Venus, the earth, and Saturn give rise to the sun's spots.

4. *Planetary data.* Table I presents most of the data required for the study of the precessional action of the planets on the sun. Other pertinent data as the periods and the masses of the planets and their distances from the sun are readily available elsewhere.

The magnitude of the precessional couple on the sun is given by

$$3 \, km \times (C - A) \sin l \sin d \sqrt{1 - \sin^2 l \sin^2 d} \div r^3 \tag{1}$$

Here

$k =$ the constant of gravitation.
$m =$ the mass of the planet.
$C - A =$ difference of the principal moments of inertia of the sun.
$l =$ the longitude of the planet measured from the node of the sun's equator on the orbital plane.
$d =$ the angle the sun's equator makes with the orbital plane.
$r =$ the distance of the planet from the sun.

Tidal action is continuous and varies inversely as the cube of the distance between the two bodies. Precessional action also varies inversely as the cube of the distance between the two bodies but it is not continuous. Twice in every revolution it becomes zero at the nodes and twice it rises to a maximum at points nearly midway between the nodes.

TABLE I

Planet	(1) Inclination of orbit to sun's equator	(2) Longitude of ascending node of sun's equator on plane of orbit	(3) Longitude of Perihelion 1930	(4) $\dfrac{(1+e)^3}{(1-e)^3}$	(5) Mean Couple Earth = 1	(6) Extreme Values of Couple
Mercury	3° 14'	327° 34'	76° 21'	3.480	.3250	.59, .17
Venus	3 47	251 50	130 35	1.041	1.138	
Earth	7 11	253 47	101 44	1.138	1.00	1.051, .951
Mars	5 34	261 50	334 46	1.753	.024	
Jupiter	6 2	248 20	13 11	1.301	1.89	2.18, 1.71
Saturn	5 29	237 5	91 40	1.398	.083	.0978, .0668
Uranus	6 25	253 48	169 31	1.329	.00186	
Neptune	6 23	240 14	44 1	1.056	.00054	

In (1) we may put $l = 90°$ and drop the constants $3k$ and $C - A$. This gives

$$\frac{m \sin 2d}{2r^3} \tag{2}$$

By means of (2) the values in column (5) were calculated.

The extreme values of column (6) were also obtained from (2) as follows: The values of r for Mercury and Jupiter were taken from the *Nautical Almanac* for a position midway between the nodes. This neglects the effect of the position of perihelion but is sufficiently accurate for the purpose. Using the orbital eccentricities the extreme values of the couples of Venus, the earth, and Saturn were calculated. All values are based on the value of the earth's couple, at the earth's mean distance, being *one*. While all these results are approximate they are near enough to the correct values to indicate the magnitude relations of the planetary couples and the extent of the variation from least to greatest values.

5. *Maxima and minima of precessional action.* On March 21 and September 23, the sun is in the plane of the earth's equator and solar precessional action on the earth is zero. On June 21 and December 22, the plane of the earth's equator is inclined to the plane of the ecliptic the maximum angle of $23\frac{1}{2}$ degrees. Near these last two epochs solar precessional action is a maximum. Moreover, the interval from March 21 to September 23 is 186 days. The interval from September 23 to March 21 is 179 days. Since precessional action varies inversely as the cube of the distance between the two bodies the two maxima at the solstices are not quite equal.

Reverse the foregoing and consider the precessional action of the earth on the sun. The earth is in the plane of the sun's equator when its longitude is $73° 47'$ and $253° 47'$. This occurs regularly about December 6 and June 5 when precessional action of the earth on the sun is zero. The intervening maxima occur about March 5 and September 7.

6. *Precessional action of the earth on the sun.* Tangible proof that the precessional action of the earth on the sun has a definite effect in producing sun spots will now be given. The adjacent graph pictures the
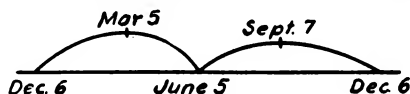
FIGURE 1

precessional action of the earth on the sun. Its least action should occur near December 6 and June 5, while its greatest effect should come near March 5 and September 7. If one finds the averages of the monthly area numbers over a long interval, they should show two maxima and two minima. Arctowski using the area measures has done this for the

forty-year interval 1874 to 1913. His results are:

Jan.	501	April	451	July	526	Oct.	519
Feb.	535	May	452	Aug.	495	Nov.	481
Mar.	484	June	413	Sept.	553	Dec.	497

(*Memorie della Societa degli Spettroscopisti Italiani,* Vol. V, 1916, pp. 98-99).

The maxima and the minima of the table agree well with the maxima and the minima of the graph. If the averages were weekly instead of monthly the agreement should be closer. Moreover, the precessional couple varies inversely as the cube of the distance between the two bodies. Perihelion occurs about January 2 and aphelion about July 4. This would make the first maximum earlier than March 5 and the second one might be in September or in August.

Consider now the monthly means of the sun-spot numbers for the 100 years, 1839 to 1938, inclusive. These are:

Jan.	43.1	April	43.5	July	45.4	Oct.	45.5
Feb.	46.9	May	44.9	Aug.	46.7	Nov.	44.0
Mar.	45.0	June	45.4	Sept.	45.8	Dec.	44.1

Thus the two maxima and the one minimum are in substantial agreement in the two tabulations. Only the first minimum differs. Yet on it the area numbers and precessional action agree.

Similar studies for Venus and Jupiter should show two maxima and two minima per orbital period of each.

7. *Precessional action of two planets on the sun.* When the moon and the sun are in opposition or conjunction the tides are greatest and when they are in quadrature they are least. Precessional action of the two planets on a *rigid* body would have like maxima and minima except as modified by the zeros due to the nodes. In fact a couple can be represented as a vector and two or more couples can be combined by vector addition.

Table I shows that the nodes of the sun's equator on the planetary orbits are, with the exception of the nodes of Mercury, in nearly the same longitude. Moreover, Table I shows that the inclinations of the sun's equator to the orbit planes are positive and lie within a range of three to eight degrees. Hence when two planets are in conjunction or opposition their combined precessional couple is nearly equal to the sum of their separate couples. The resulting action is localized over two areas on opposite sides of the sun. The points of maximum action in these areas lie on the solar meridian on which the two planets are.

Unlike tidal action, in which the effects of quadrature of the moon and the sun are regular, precessional action of two planets in quadrature is complicated by the fact that one may then be at a node. Nor can two planets in quadrature ever exert their maximum action. The precessional action of two planets in quadrature even if each is considerable is exerted on portions of the solar belt which are far removed from each other

on the solar surface.

Now sixty per cent of the solar spots are bipolar and observers agree that the tendency to bipolar spots is almost universal (Abetti, "The Sun," p. 203). In the words of Moulton, bipolar spots are "vortex" cylinders ("Astronomy," 1931, p. 363). If two planets unite in producing one vortex cylinder, rather precise alignment in latitude and longitude is required of them. It seems certain that if two planets were a few degrees in longitude from opposition or conjunction, the action of one would tend to interfere with the production of spots by the other because the axes of the two nascent cylinders would be inclined at an angle which would increase until quadrature. It seems, therefore, that any planet would interfere with the spot production of a faster-moving planet except when the two are near conjunction or opposition, provided neither is near a node. This interference may prevent the formation of double spots or actually diminish spot production. Thus though Jupiter's couple is twenty times that of Saturn, the latter may, except near conjunction or opposition, interfere with the spot production of Jupiter and diminish it.

In general, spurts of sun-spot activity may be expected to follow conjunctions or opposition of Venus and the earth with Jupiter. At least they are likely to do so at certain epochs and sure to fail at others. Diminution of spot production may be expected to follow nodes of Venus, the earth, or Jupiter. Moreover, quadrature of two planets means a decrease in spot production. This is particularly true of quadratures of Venus with the earth.

Inspection of the graph of Section 9 will show that in one year precessional activity on the sun may have eleven brief increases due to conjunctions or oppositions of Venus, the earth, Jupiter, and Saturn. There may be eleven decreases due to quadratures. Five other decreases due to nodes of Venus and the earth are possible. This gives for these four planets a total of twenty-seven critical positions yearly.

Thus it is evident that the precessional interaction of these four planets in the production of sun spots is a highly complicated phenomenon. The couples for Venus and the earth are about half that of Jupiter. Under suitable conditions the two former may sharply affect the total activity and advance or retard the epochs of maxima and minima.

Certain periodic interactions remain to be noted. These are easily seen by inspection of the graph. At Jupiter's maximum, conjunctions and oppositions of Venus with Jupiter occur nearly midway between the nodes of Venus. This is their most effective position. It is due to the fact that the nodes of the sun's equator on the orbits of these planets are in nearly the same longitude. When Jupiter is near a node, conjunctions or oppositions with Venus occur when the latter is also near a node. This is their least effective position for combined spot production. The periodicity here noted agrees with Jupiter's major precessional period of 5.63 years and also with its minor precessional period of 6.23 years.

For like reasons two similar periodicities hold for Venus and Saturn and two others for Uranus and Neptune, respectively.

In like manner the conjunctions of the earth with each of the major planets are governed by similar periodicities. The cumulative result of this is extremely significant. The effects of the conjunctions and oppositions of Venus and the earth with Jupiter reach their maxima nearly at the times of Jupiter's maxima. This occurs not occasionally but with perfect regularity. The periodicities of Venus and the earth with Saturn are next in importance and they are equally regular.

8. *Explanation of the graphs.* The irregular sun-spot curve based on the *observed* monthly means is well known. It should be possible to trace some of the peaks and lows to precessional action, particularly to that of Venus, the earth, and Jupiter, the three most active planets.

In the graph the precessional action of Mercury, Venus, and the earth are indicated by curves, that of Jupiter and Saturn by straight lines inclined to the time axis and running from nodes to maxima, respectively. The eccentricities of the orbits of Mercury, Jupiter, and Saturn are allowed for, while the orbits of Venus and the earth are regarded as circles.

Mercury's 32-day period is about three times as active as its 56-day period. The graph shows this.

The aim of the graph is to establish time coincidences. Consequently the amplitudes of the precessional graphs are not proportional to the real amplitudes. The amplitudes were chosen so as to display clearly the numerous critical positions. The legend accompanying the graph states the meaning of the various symbols used on it.

In some intervals, precessional action and interaction are clearer than in others. A minimum of Saturn occurred in October, 1927, and a maximum of Jupiter in April, 1928. Here where Jupiter's action is great, and where Saturn's action is near zero, the precessional action of Venus and the earth should register visible increases and decreases in the steady action of Jupiter. Part of the interval 1927-1930 and a few others will be studied in some detail.

9. *The graphical evidence.* (a) The first low in 1926 comes between a node of Venus and its quadrature with Jupiter. The node of the earth in June is obscured by the activity of Mercury and the line-up of Venus with Jupiter late in May. The effect of the node of Venus in August is obscured by the line-up of the earth with Jupiter. The low point of the area curve in July comes between the earth's node in June and that of Venus in August. It appears to be determined by the quadrature of Venus with the earth early in July. These quadratures occur every 292 days and are very effective. The third low point in November comes earlier than the nearly coincident nodes of Venus and the earth early in December. The two quadratures in October and the activity of Mer-

cury in October and December help to displace the effect of the double node.

The marked activity in January, February, and March is due to the line-up of Venus and the earth with Jupiter followed by the conjunction
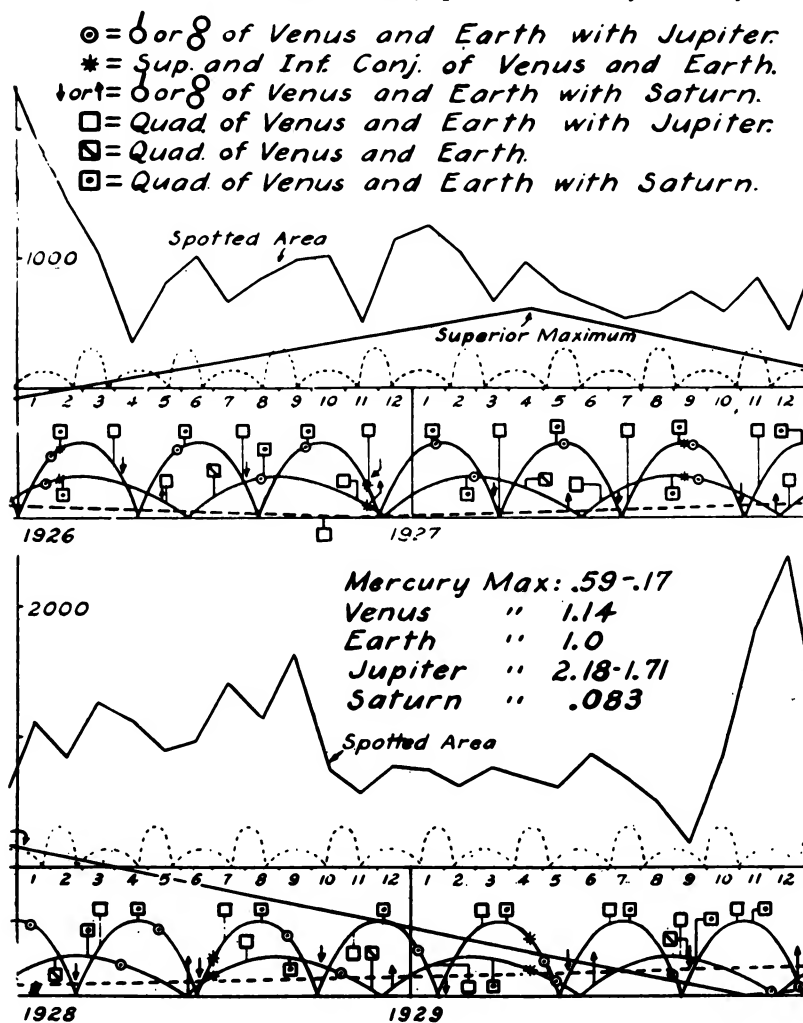
FIGURE 2

of Venus and the earth. Mercury adds to the activity in February and March. The peak in June is due to the line-up of Venus with Jupiter in May and to Mercury's activity in May and June. The sustained activity in August, September, and October is due to the line-up of the earth with Jupiter, Venus with Jupiter, and to Mercury's activity in August and September.

(b) The year 1927 has four low points in the area curve and five nodes. The node of Venus in March registers as the first low point. The node of the earth in June is obscured by the line-up of Venus with Jupiter late in May. The node of Venus in July registers in the curve. The diminished activity following Jupiter's maximum is due to quadrature of the earth with Venus in April, the node of the earth in June and the node of Venus in July. The effects of the node of Venus in October and of the earth in December are displaced by the activity of Mercury in October.
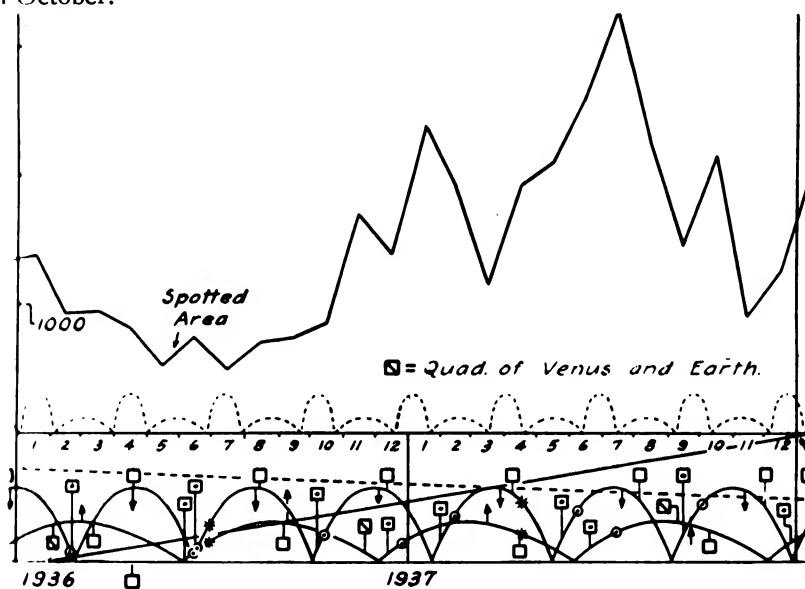
FIGURE 3

There are four peaks in the area curve for 1927. The sustained activity in January and February is due to the line-up of Venus and the earth with Jupiter and to the activity of Mercury. The peak in April is due to Jupiter's own maximum. Mercury and the conjunction of Venus with Jupiter help to sustain the activity in May. The cause of the peak in September is clear. The peak in October is due to Mercury.

During the years 1926 and 1927, the effect of quadratures of Venus and the earth with Jupiter is small and they decrease toward zero.

In like manner the reader can account for the highs and lows of 1928 and 1929. A brief comment will be made on the interesting peak in December, 1928. Jupiter, the earth, and Saturn contribute nothing to this peak. It is due mainly to the activity of Venus and Mercury.

Only a few comments will be made on the years 1936 to 1939. Saturn's activity makes interpretation of 1936-1937 less simple than 1926-1927. Note the conjunction of the earth and Venus in April, 1937, the line-up of Jupiter with Venus in June and with the earth in July, the increasing

activity of Jupiter during the year and the activity of Mercury in March-April and in June-July. Here is the precessional basis for the exceptionally high continued sun-spot activity from March to September.

The reader can easily trace the peaks and lows of 1938-1939 to precessional action. The September area number is unprecedented. Venus and the earth are then in conjunction. Jupiter is lined up with each and Mercury is active. This is the unusual basis for the precessional activity and the consequent sun-spot activity.

Note that the lows of June, 1938, March, 1939, and December, 1939, are the lowest in this two-year interval. While nodes of Venus and the earth are contributory the quadratures of Venus with the earth are also
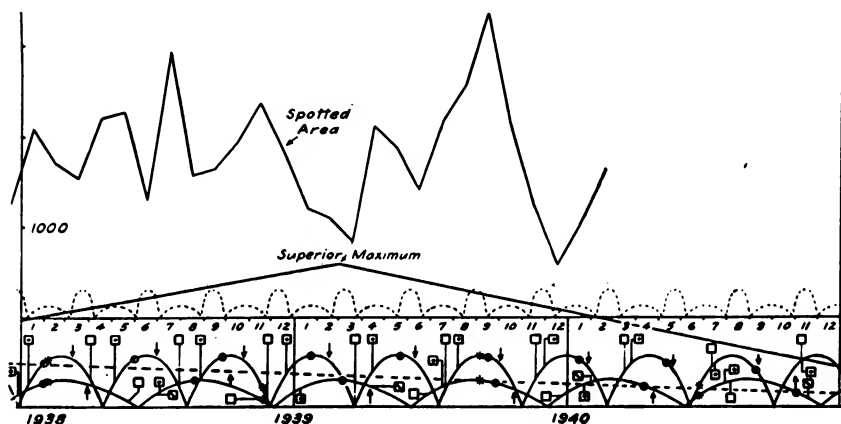
FIGURE 4

concerned. It is very significant that one of these lows comes at Jupiter's maximum. It is determined by a node of Venus and the quadrature of the earth with Venus.

10. *Analyses of the sun-spot data.* Many analyses of the sun-spot data have been made by various methods. Unfortunately the sun-spot data back to 1749 have usually been employed. The weights given to dates previous to 1826 by Wolf and Wolfer indicate that the data before Schwabe's observations are uncertain. There is other evidence of the unreliability of the data referred to. For example, Kimura analyzed the data from 1750 to 1910 and found 29 periods, with their respective epochs and amplitudes. He recombined these into a resultant curve which agreed with remarkable fidelity with the data curve over the whole 160 years. He projected this curve forward to 1950 and it does not fit the record for 1910 to 1940. This is the result of using 77 years of faulty data.

If the monthly means are averaged from 1749 to 1913, inclusive, the results as given by Arctowski are:

Jan. 43.4	April 44.8	July 44.6	Oct. 45.6
Feb. 45.6	May 45.9	Aug. 44.8	Nov. 45.5
Mar. 44.3	June 45.9	Sept. 45.0	Dec. 45.2

(*Memorie della Societa degli Spettroscopisti Italiani,* Vol. V, 1916, pp. 98 99).

Here unreliable data mask the maxima and minima found in section 6 for the interval 1839-1938.

The synodic period of Venus and the earth is 584 days. From conjunction to opposition it is 292 days. In numerous places the highs and lows in the graphs of this paper indicate the maxima due to conjunction and the minima due to quadrature.

The synodic period of Jupiter and the earth is nearly 400 days. The interval between conjunction and opposition is about 200 days. Elsa Frenkel, using Schuster's periodogram analysis, made a search for short periods in the sun-spot data of 1876 to 1911, inclusive. She found a 200-day period (*Publ. der Sternwarte Eidg. Polytechnikunst,* Bd. V. S. 47). It is interesting to note that the interval here used was nearly the same as that used by Arctowski (See Section 6).

A most interesting analysis is a recent one by Clayton (*Smithsonian Miscellaneous Collections,* Vol. 98, Number 2). He used the sun-spot data from 1793 to 1936. This excludes 44 years of defective material. His results are:

Length	Ampl.	Length	Ampl.
5.56 yrs.	4 spots	11.17 yrs.	35 spots
8.12 yrs.	6 spots	11.90 yrs.	15 spots
8.94 yrs.	10 spots	14.89 yrs.	9 spots
9.93 yrs.	13 spots	19.86 yrs.	4 spots

The connection of these with planetary periods is remarkable. The 5.56-year period nearly equals Jupiter's major precessional period of 5.63 years. The mean synodic period of Jupiter and Saturn is 19.86 years. Half that period, 9.93 years, is the mean interval from conjunction to opposition. The 11.90 years nearly equals Jupiter's period of 11.86 years. Saturn's precessional periods are 14.12 years and 15.34 years, respectively. The 14.89 lying between these two is nearly half Saturn's orbital period of 29.46 years. The remarkable character of the analysis is seen when results are summarized. Out of eight periods one, 11.7 years, is apparently the mean length of the sun-spot cycle in this interval, two others, 9.93 and 19.86, agree to hundredths of a year with the Jupiter-Saturn periods, and two others, 5.56 and 11.90, agree within less than a tenth of a year with the Jupiter periods. This appears to be a striking confirmation of a planetary cause of the sun spots.

The writer published in the *Astronomical Journal* of August, 1930, an article, "On the Cause of the Sun's Spots." It was a study of the precessional action of the four major planets which compared it with the yearly mean of the area data from 1836 to 1930. The adjacent graph illustrates an important conclusion of that paper concerning the length
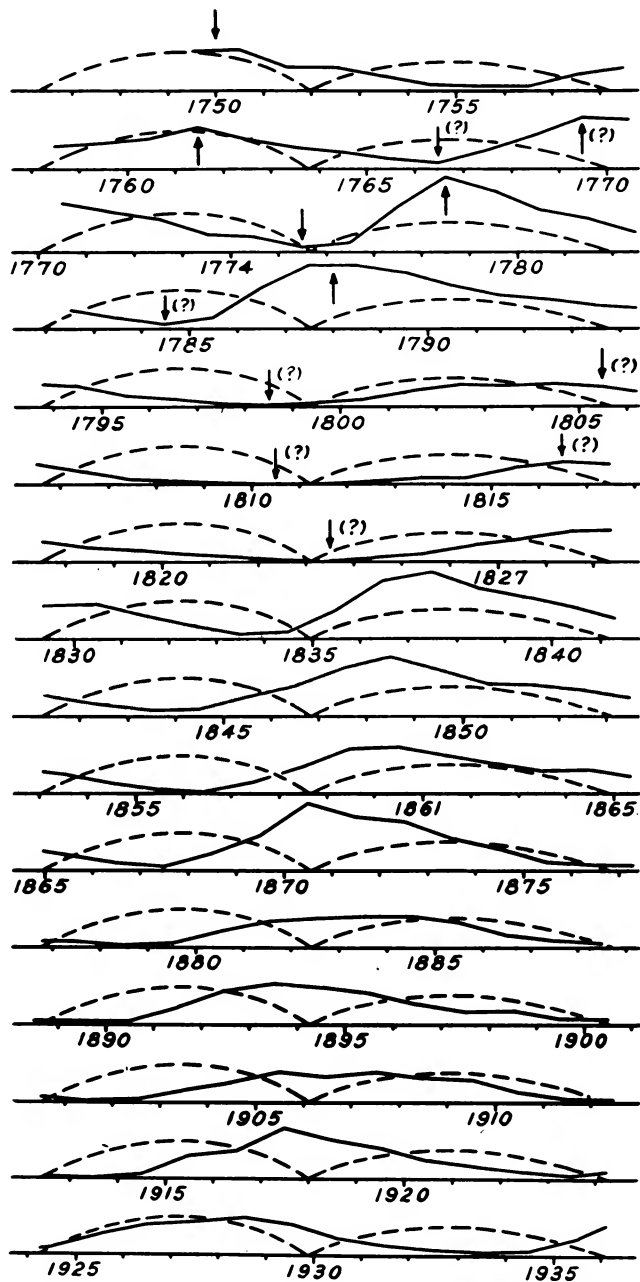
THE SUNSPOT NUMBERS 1749-1938
AND JUPITER'S PRECESSIONAL
ACTION ON THE SUN

Figure 5

of the sun-spot cycle.

The graph compares the sun-spot data from 1749 to 1937 with the precessional action of Jupiter alone. It is seen that from 1830 to 1940 sun-spot maximum comes after Jupiter's superior maximum and before its inferior one. In the interval 1749 to 1930 only three of the maxima set by Wolf come within the corresponding interval. The dates of these are 1751, 1762, and 1788. The net result is that between 1749 and 1835 *eight* maxima have been inserted where there should be only *seven*—one for each complete precessional period of Jupiter. The graph makes obvious the glaring inconsistency of the sun-spot data from 1749 to 1825 inclusive with the 114 years of reliable modern data from 1826 to 1939.

Now Staudacher's observations were scanty.* Yet they are the only reliable ones preceding 1826. Probably the maximum of 1750.3 which is based on them is nearly correct. The interval 1750.3 to 1928.4 divided by 15, the correct number of cycles in the interval, gives 11.87 years as the mean length of the sun-spot cycle.

11. *Some mechanical aspects of sun-spot phenomena.* If sun spots are caused by precessional action of the planets, it should be possible on that basis to explain many features of sun-spot phenomena which recur in every cycle. A few will now be examined to see if they are a dynamical consequence of precessional action.

Table I shows that for six of the planets, including the earth and Jupiter, the angles which their orbit planes make with the plane of the sun's equator lie between 5° 31′ and 7° 15′. When at their maximum these planets tend to pull material of the solar belt some eleven or twelve degrees wide southward during half a solar rotation and northward during the next half. This reversal of action seems to be the reason that spots are very infrequent from about +5° to —5°.

In the higher latitudes the tangential component toward the equator decreases and the thickness of the solar belt does also. This explains why spots are infrequent nearer the poles than ±30°.

It appears possible to explain the equatorial acceleration of the sun on the basis of precessional action as follows. Material is pulled equatorward by precessional action and compresses other material making it more dense. The denser material tends to sink and increases the pressure below. Compensating motion of material to restore the disturbed equilibrium will be upward or poleward or both. Material coming from below upward will have a smaller eastward velocity than the material at the surface. Material moving equatorward will pass a distance d_1 to the west of meridian from which it started. The returning material will pass to the east of the meridian from which it started, a distance d_2. Friction in the two cases will make d_1 unequal to d_2. That is, if these two motions were made by the same material it would, on returning to its original

*See "Mean Period of Sun-Spots" by the author, in POPULAR ASTRONOMY, **36**, Nos. 9 and 10.

latitude, be west of its first position by some small fraction of $d_1 + d_2$. The integrated total of these countless interchanges produces the equatorial acceleration.

As another example the polarities of leader spots in the two hemispheres will be considered. Double groups are about twice as numerous as single spots. Abetti writes:

> "The tendency toward bipolar spots is almost general in sun spots, for even in cases where the spots are single there are often traces of asymmetry due to the presence of faculae or flocculi following or preceding the spots" ("The Sun," page 203).
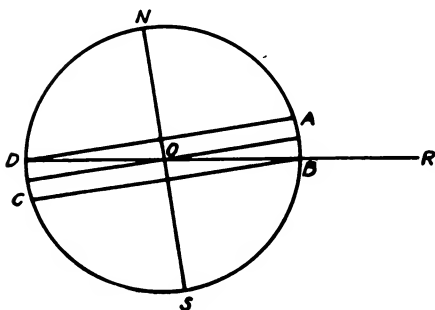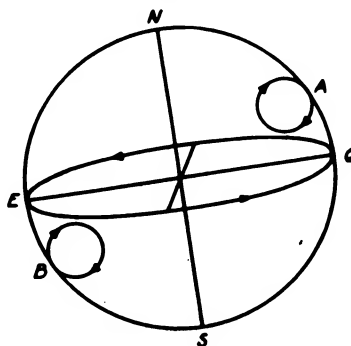
FIGURE 6   FIGURE 7

Moulton writes:

> "They (Hale and his associates at Mount Wilson) found the important fact that the polarities of neighboring spots are nearly always opposite, implying that their gyratory motions are in opposite directions. This fact suggests that neighboring spots are usually connected by a huge vortex cylinder, the spots themselves being merely the surface ends out of which the material rises" ("Astronomy," 1931, page 363).

The fact appears to be that precessional action causes a vortex cylinder to rise to the surface. *Now whatever the direction of rotation of a vortex cylinder which is produced by precessional action at* A *in the northern hemisphere, the same direction will be produced at* B *in the southern.* Suppose that a "vortex cylinder" at A rotates clockwise. Then one at B will also rotate clockwise. If the direction of rotation of the sun is as indicated, one views at A the trailer end of the "vortex cylinder," while at B one looks at the leader end. Consequently a trailer spot in the northern hemisphere should have the same direction of rotation as a leader spot in the southern and *vice versa*. Presumably the direction of rotation determines the polarity. If so, this would account for the polarities of leader spots and trailer spots in the two hemispheres.

12. *Summary*. This study proposes the precessional action of certain planets on the sun as the cause of the sun's spots. It is an application of elementary dynamics to that problem based on the reliable modern observations; that is, those made since 1825. The combined action of the five more active planets Mercury, Venus, the earth, Jupiter, and Saturn

turns out to be one of great complexity. Nevertheless, in selected intervals, the effect of the precessional forces can be seen to register in the area curve. The appeal to the observations and to analyses of them is continuous and varied. Each of the preceding eleven sections makes its own point and there is no need to repeat them here.

It should be pointed out that this study harmonizes the work of De la Rue, Stewart, Loewy, Pocock, Maunder, Schuster, Arctowski, and others and confirms the view of all those astronomers who have believed that sun spots are due to planetary action by assigning an adequate gravitational cause and by showing in detail how that cause operates.

THE UNIVERSITY OF KANSAS CITY,
KANSAS CITY, MISSOURI, JULY, 1940.

The Revelation in Thunder and Storm
Summarized by MICHAEL S. KISSELL

From time to time we receive requests for papers in which the technicalities of modern astronomical research are not the main considerations. We believe the following paper will fulfill such requests. It shows the antiquity of the beginning of the science of astronomy and also demonstrates that the regularly recurring celestial phenomena are the most dependable connections between the past and the present. In a word, we may, in the course of a year, witness essentially the same stellar procession as was seen by those persons who lived twenty centuries ago. EDITOR.

HISTORICAL NOTE

Mr. N. Morozov, the author of the book under the above title, was born and lived in Russia, and, because of his socialistic activities with the intention of overthrowing the Imperial government existing at that time, was imprisoned in the Shlisselburg Fortress. The only book that was given to him for reading during the early days of his imprisonment was the Bible.

This happened in the autumn of 1882. When reading the Apocalypse (The Book of Revelation), it occurred to Mr. Morozov that some names referred to were at the same time the names of various constellations. Therefore, assuming that the whole book of the Apocalypse was a mere description of a particular picture of the sky presented in a form of a special code, Mr. Morozov engaged himself in a detailed study of all available material related to the Apocalypse, and made all the necessary astronomical calculations supporting his theory as to the origin of the Apocalypse. (Under the Imperial Government the non-criminal prisoners, who were also known as "political prisoners," had the privilege of reading books, magazines, newspapers, were permitted to write essays,

compositions, etc., and were not subjected to convict labor. In fact, this very book was written by Mr. Morozov during the time of his imprisonment.)

Upon his release, in November, 1905, Mr. Morozov published his book under the title "The Revelation in Thunder and Storm," dedicating it to his friend Miss Vera Figner, imprisoned in the same Fortress.

It is of interest to note that one of the books that Mr. Morozov studied during his research was "1. Newtoni Opera T. V. Londini. 1785." This book is the Apocalypse in the interpretation of Sir Isaac Newton. Mr. Morozov is of the opinion that such a genius as Newton undoubtedly recognized the astronomical portion of the Apocalypse, but perhaps it was Newton's preference not to disclose it to his readers.

The present paper is by no means an accurate translation of the entire book which contains over 300 pages, but is rather a closely followed sketch of the contents of the original material, being rather an abstract, but not a translation, of the text which is somewhat pleonastic. While I carefully preserved the meaning of the text and positively made no changes, I took the liberty to make several additions which do not appear in the original text, but which do support Mr. Morozov's theory. Moreover, there is a case in which I disagree with Mr. Morozov, but then I state this fact in the text, giving my reason.

Several years ago it occurred to me that it would be of great scientific interest to re-enact certain parts of the Apocalypse in the Planetarium. For this purpose I communicated with the directors of two Planetariums in this country, but in both cases the directors, acknowledging a sufficient scientific interest in such an undertaking, had to decline it for some other consideration not related to science.

I.

Among all the difficult problems that we may encounter while studying a distant and strange historical epoch is the necessity not only to understand clearly the foreign method of thinking and strange conceptions of the world, but to be able actually to reincarnate ourselves into the souls of men buried a long time ago in historical cemeteries. We have to mobilize our ability to respond to such an extent as to give some characteristics of the intellect of the men of that time, on the basis of only a few fragments. We must make ourselves not only able to understand that intellect, but actually feel, think, love or hate, the way *they* did, and believe in many things which in our age we do not and cannot believe. The majority of us would probably have a great difficulty in re-adjusting our feelings and thoughts to the required extent. Such inability is easily understood. For instance, how could a person who never tasted the fruit of a bread-tree possibly imagine the flavor of that fruit? Or, how could a person who never smoked opium clearly understand the mental state of those who indulge in it? In our age we grow from childhood with beliefs that such things as stones, trees, and clouds are inani-

mate objects. Could we possibly understand savages who sincerely offer their prayers to wooden or stone idols? If we *can* join them in their prayer with all sincerity, then we *really* understand them.

Perhaps it is for this reason that the best students, and the most qualified investigators on matters dealing with the distant past, are those who combiné in themselves the benefit of modern education with the understanding of outlived superstitions and creeds that perhaps were imparted to them by their old and rather ignorant nursemaids. Mr. Morozov, in this respect, was particularly fortunate. He was fairly well educated in the modern sense, yet on the other hand, in his childhood, he grew under the influence of his nursemaid, a simple old woman taken from a village, who during the long winter evenings implanted in his brain her own outlived conceptions.

Our globe was understood to be a flat disk of earth covered with a glass-like dome—Heaven, on the top of which stood a throne, and upon the throne sat God, a tall old man with a long white beard, who was always surrounded by a host of praising angels, and saints kneeling in front of Him. The stars were some sort of candles that were lit during the night, each actually representing a human life. When a shooting star was seen, it meant that the corresponding human life on earth had expired. All objects of Nature were animate; each tree, post, or stone had its own life and soul, and was able to communicate its thoughts to another. The leaves of trees spoke to each other by rustling, the waves of the sea by splashing, and the clouds in the sky were just playing, chasing each other into infinity, for some definite purpose unknown to us, and just responding to their own caprices, continually changing their shapes, assuming some fantastic forms of animals or the like.

Nature was full of mysteries; each comet with its train was interpreted with apprehension, by the elders, as a fiery sword, and signified an approaching war, invasion, or some other form of bloody event. Each meteor flying through the night sky was a dragon with a fiery tail, or a fiery spear thrown by one invisible being into another hostile one.

It appears that the ancient historians placed much importance in these "Heavenly Signs," and therefore each such event was accurately entered in the chronicles among other simple events of their lives. For example, here are a few such entries made by various historians appearing in the book of Astronomy by Arago:

　952　There was a dragon in the sky.
　1462　God sent large stones that fell from heaven.
　1665　A number of fiery spears were observed towards North.
　838　There was a fire in the sky—shape of a dragon.
　918　The fiery spears of various colors appeared in the sky and seemingly flew towards each other.
　561　There was a fire running across the sky—during the same night Clotarius had died.
　876　A terrific number of spears as never before was observed in the sky. They say it looks like a rain of blood.

These are some typical entries in the Chronicles of ancient history. One

could imagine what a great number of superstitious interpretations was inspired in the ancient times by the lack of knowledge of the nature of these phenomena.

During the first centuries of our era, science was substantially on the level of fortune-telling, at least that would hold true of Astronomy, or more precisely of its Mother-Science, Astrology. It really had happened for the following reason: The early people felt confident that it was *they* who really were the crowning achievement of the Creation, and all the rest was made for their use or pleasure. While, perhaps, it did not take very long to find some use for all the earthly objects, and for the sun and moon, the purpose of stars and planets was more intriguing than obvious. Nevertheless they must serve men in some way, otherwise they would not have been created at all.

They knew well that thunder and lightning in heaven predict an approaching storm, and undoubtedly all other phenomena in the sky likewise had some significance. The only question being—to find the proper interpretation.

For instance, long before the Christian Era, perhaps at the time of their conception, the 12 figures of the Zodiac had only symbolical meaning. However, in the course of time each of the twelve was considered to be an actual figure invisible but existing on the crystal-like dome of Heaven. Planets and stars were considered as actual beings exerting a powerful effect upon all earthly events.

The planets, or so-called "wandering stars," during the period of Rome, obtained names of Roman gods: Mercury, Venus, Mars, Jupiter, Saturn, and, as time gradually went on, they acquired specific characteristics peculiar to their own color. While on the other hand, in the interpretation of astrologers, it was the color that was the result of their characteristics. For instance, when the "blood-thirsty" Mars was in the sign of Leo, it was believed very dangerous, and bloodshed was certain. When "malicious" Saturn entered the sign of Scorpio, this was still worse, and epidemics or other tribulations were predicted because both of them, Saturn and Scorpio, were symbols of death. Therefore, in order to understand certain expressions used in ancient books, one should have some knowledge of the apparent motions of heavenly bodies.

At the present time it is well known that the irregular and loop-like motions of the planets are only apparent, but in the olden times it seemed quite mysterious that a certain planet begins to retard its motion, comes to a complete stop, goes backwards, and then all of a sudden resumes the forward motion in an accelerated manner, resembling a horse that reared and then sprang forward.

It is for this reason that, before the time of Copernicus (1543 A.D.),*

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*In fact, a Greek astronomer by the name of Aristarchus, who lived in the third century B.C., was the first one to demonstrate that the earth as well as other planets revolve around the sun. Some 1800 years later, his theory was rediscovered by Copernicus, who has all the credit and historical recognition for the discovery.

the ancient astronomers called planets "horses," and if it should happen that a planet was found right under a certain sign of the Zodiac, that sign was considered the "rider" mounted on that particular "horse" and galloping on the crystal dome. It is of interest to note that on the face of certain ancient coins there is reproduced one or another sign of the Zodiac mounted on a horse, or a horse jumping over a sign of the Zodiac.

II

We know that the Apocalypse was written centuries ago in the beginning of the Christian era. We also know that the scientific papers at that time were written in a manner totally different from that of the present time. While at the present time the author tries to make himself clear to every reader, in the olden days the scientific papers were purposely worded in such a manner that only an initiated person could grasp the true meaning of every paragraph. Thus, if on this basis we could assume that the author of the Apocalypse was really referring to the planets when he wrote "horses," then the "Four Horsemen" of the Apocalypse could be easily deciphered. If this assumption is correct and the author of the Apocalypse merely described a picture including four planets that he saw in the sky, then it is most likely that there should be a number of other heavenly bodies that he observed, and referred to under some ficticious names that offer only a slight hint for identification of a star or a constellation.

It is astonishing how true this assumption proves to be. For instance, Rev. 4:5—

> . ., . and there were seven lamps of fire burning before the throne, which are the seven Spirits of God.

Could it be a coincidence that in certain places as in southern France, for instance, the constellation of the Big Dipper even until now is called "Chariot of Souls"? Elsewhere, the Big Dipper is known as the "Seven Lanterns." So, if we assume for a minute that the seven burning lamps, mentioned in the fifth verse, are the seven stars that compose the Big Dipper, then the next assumption suggests itself that the "Throne," in front of which the seven lamps are burning, could not be anything else but the constellation of Cassiopeia. As a matter of fact, the constellation of Cassiopeia was also called "Lady in the Chair," "Queen's Throne," or simply "Throne." So, suppose we read the next few verses with anticipation that some of them may convey information related to astronomy. In 4:6 we read—

> . . . and before the throne there was a sea of glass like unto crystal; and in the midst of the throne and round about the throne were four beasts, full of eyes before and behind.

Then from our new point of view it seems evident that the crystal-like sea is perhaps nothing but the sky which apparently turns around the "Throne" in its diurnal motion. If our anticipation is correct, then the

"Four Beasts" mentioned in the closing of the verse should be also found in the sky, and just on the premises that "they were full of eyes before and behind," it is most likely that they shall be some four conspicuous or well known constellations.

True enough, for in 4:7 we read—

> . . . and the first beast was like a lion, and the second beast like a calf, and the third beast had a face as a man, and the fourth beast was like a flying eagle.

The information obtained from this verse suggests an elegant and easy solution. Since among the constellations of the Zodiac there is one of "Lion," another, "Taurus" (a calf), the third "with a face of a man," "Aquarius," we feel rather certain that the fourth one, "like a flying eagle" should also be found among the constellations of the Zodiac. However, as a matter of fact, among the variety of "beasts" of the Zodiac, at least if we use the twelve names that are generally accepted at the present time, we find none with wings. Mr. Morozov presumes that the constellation referred to is "Pegasus" (the "flying horse"). However, this is a point where I decidedly disagree with Mr. Morozov. I feel convinced that the constellation referred to as the "flying eagle" is the constellation of "Scorpio." There are four reasons for such a conclusion:

1. The constellation "Pegasus" has the face of a horse instead of that of an eagle.

2. The knowledge of the Zodiac could descend to Jews by means of two channels: (a) When Terah (the father of Abraham) was expelled with all his family from the city of Ur of the Chaldeans by order of the King, he migrated to Haran (Gen. 11:31) with Abraham, and they may have brought with them the knowledge of the Zodiac. (b) It is also possible that the Jews learned the Zodiac from the Babylonians during the period of captivity. But whatever the source was, it appears that for some obscure reasons, they changed the name of the constellation of "Scorpio" to "Eagle." The fact is that the name "Eagle" was used by Abraham's followers. For example, Ezekiel 1:10—

> . . . as for the likeness of their faces, they four had the face of a man and the face of a lion, on the right side: and they four had the face of an ox on the left side; they four had also the face of an eagle.

3. Because under such assumption we find all four constellations in the belt of the Zodiac, its constellations being supposed to exert a mysterious power on men.

4. Because the author of the Apocalypse is far from referring to "some" four casually chosen constellations. It should be noted that the constellation of "Lion" is exactly opposite that of "Aquarius," and that "Taurus" is exactly opposite "Scorpio." Moreover, these four constellations divide the sky into four equal parts of 90° each.

The obvious truth will become more conspicuous if we recall that the

ancient papers of the Persians reveal the existence of "Four Brilliant Stars" indicating the true North, South, East, and West. It is a delight to discover that there are four beautiful radiant stars in the sky, and that all of them lie in the constellations referred to, namely:

Regulus	in Leo
Fomalhaut	in Aquarius
Aldebaran	in Taurus
Antares	in Scorpio (Eagle of the Hebrews).

It is also interesting because some 3000 years before our era, the position of Fomalhaut indicated the true North, Regulus—the true South; Aldebaran—the true East; and Antares—true West. It is also significant that the author of the Apocalypse uses the names of the "beasts" in a definite order: South, East, North, and West—*i.e.*, in perfect rotation. Perhaps it would be of interest to note that this analysis incidentally reveals grave errors of punctuation in the translation of the text of Ezekiel 1:10. If, instead, the above text taken from the Bible (I used The Holy Bible, Hardings' Royal Quarto Edition 1859), it were punctuated in the manner suggested below, then its clear sense will be seen, while it certainly is self-contradictory with its present punctuation.
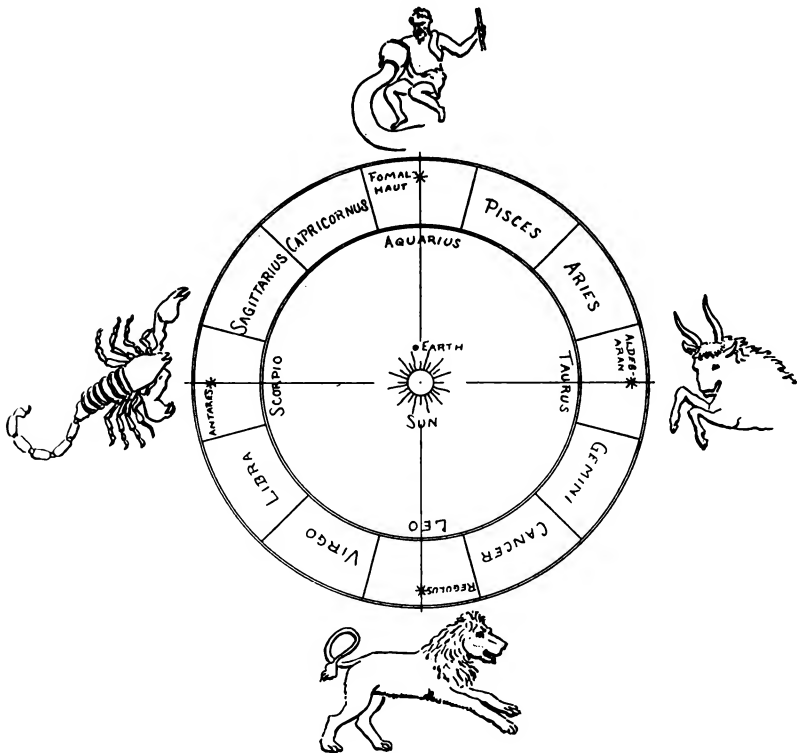
FIGURE 1 (THE ZODIAC)

The present punctuation:

> As to the likeness of their faces,
> they four had the face of a man and the
> face of a lion on the right side;
> And they four had the face of an ox on the left side;
> they four had also the face of an eagle.

The suggested punctuation:

> As to the likeness of their faces, they four had:
> The face of a man, and the face of a lion;
> On the right side they four had the face of an ox;
> On the left side they four also had the face of an eagle.

And that is exactly what Figure 1 represents. While with the former punctuation, South is shown to the right; East is shown to the left; and the position of the West (the Eagle) is not shown at all. As a matter of fact, it appears that I have a perfect right to place the punctuation in this manner, or in any other manner, for the reason that (as it was explained to me by Mr. G. L. Rubin of the Semitic Division of the Library of Congress) in the original Hebrew text of the Bible, there was no such thing as punctuation whatsoever. Even the words were not separated from each other; and each translator inserted all the punctuation signs, following no rules whatsoever, but made them "just the way he felt about it."

It appears that in Rev. 4:7 and Ezekiel 1:10 both authors emphasize their reverence for the Four Cardinal Points. The significance of this reverential regard toward four cardinal points is not known to me; however, years ago I personally observed an old custom (of unknown origin) which is practiced among Russian peasants, *viz.*, making a sign of the cross and bowing "towards all four sides" as a solemn proof that the following speech is "Truth and only the Truth." The eighth verse of Chapter 4, unexpectedly offers further proof of the correctness of our theory, Rev. 4:8—

> . . . and the four beasts had each of them six wings about him; and they were full of eyes within: and they rest not day and night, saying, Holy, holy, holy, Lord God Almighty, which was, and is, and is to come.

It follows, that each beast had six wings (most naturally three on the left and three on the right). Inasmuch as an ordinary wing is more or less of triangular form tapering towards its end and is slightly convex, they do resemble spherical triangles (of the sky) tapering towards the pole. Could we interpret the meaning of this verse as:

> And each of the four cardinal points had six strips of the sky about it (hours of Right Ascension) which were filled with stars: They never interrupted their mysterious rotation Admiring the Omnipotence of the Deity, manifested in His creation . . .

That certainly would be a poetical description of the Night Sky. Verse 10 is in full harmony with our theory and even more convincing that our assumption is correct:

> The four and twenty elders fall down before him that sat on the
> throne, and worship him that liveth for ever and ever . . .

Undoubtedly, the twenty-four elders are twenty-four hours, that in their
rotation around the pole (or, since the constellation of the throne is not
far from the pole, it is permissible in more poetical form to say "around
the *throne*") they do ascend on one side and descend (or more poetically
"fall down before the throne") on the other side.

Fortunately, the Apocalypse reveals in more than one place, that the
author simply *recorded what he saw*. For instance, Rev. 1:2—

> . . . His servant John* who bare record of the word of God, and
> *of all things he saw.*

Rev. 1:11—

> . . . and what thou seest, write in a book . . .

Rev. 1:19—

> . . . write the things which thou hast seen, and the things which,
> are, and the things which shall be hereafter.

Therefore we feel encouraged to assume that John merely described the
picture of the sky that he observed at the time when he was writing the
Apocalypse, and presently we shall make an effort to investigate whether
he furnish enough data to enable us to determine the exact date when his
book was written. If we succeed, then it will follow that John purpose-
ly recorded the time when his book was composed, and he recorded it by
means of eternal letters imprinted in the sky, which no one could pos-
sibly forge. Let us read very carefully: Rev. 6:2—

> . . . and I saw, and behold a white horse; and he that sat on him
> had a bow, and a crown was given unto him, and he went forth con-
> quering and to conquer.

So, if all "horses" should be planets, then what planet could possibly be
the White Horse? As to the color, perhaps either Jupiter or Venus, but
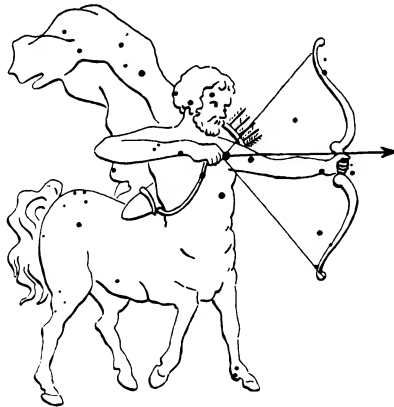
FIGURE 2 (SAGITTARIUS)

*Hereafter the author of the Apocalypse will be called "John."

inasmuch as it is mentioned that "he went conquering" and "the crown was given unto him" it could be only Jupiter. The horseman, who mounted Jupiter, had a bow. There is only one constellation with a bow in the sky, namely, Sagittarius. Therefore, we shall put the contents of Rev. 6:2 on record in the following words:

> (1) At the time the Apocalypse was written, the planet Jupiter was observed in the constellation of Sagittarius.

We read further in Rev. 6:4—

> . . . and there went out another horse that was red; and power was given to him that sat thereon to take peace from the earth and that they should kill one another and there was given unto him a great sword.

It is quite obvious that the planet in question is Mars, because this is the only planet of red color. The rider "that sat thereon" had a great sword. There is only one constellation in the sky with a "great" sword, that is Perseus. Therefore, the contents of the 4th verse we put on record in the following words:

> (2) At the time when the Apocalypse was written, the planet Mars was located under the constellation of Perseus.
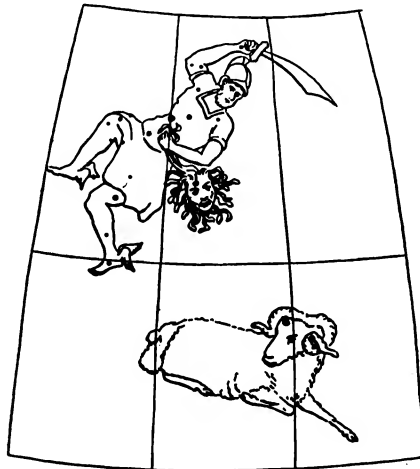
FIGURE 3 (PERSEUS AND ARIES)

Furthermore, in Rev. 6:5 we read:

> . . . And I beheld and lo a black horse and he that sat on him had a pair of balances in his hand.

The black horse of all the planets could be only Mercury, for the following reason: The Greek word that is used for black, also means *dark* and *obscure* and is a synonym for *inconspicuous*. Of all the planets it could be only Mercury. Firstly, because, however bright Mercury may be, it is difficult to observe it because of the sunlight surrounding it; and, secondly, because Mercury could not be seen with the naked eye, save on

some rare occasions. Moreover, in verse 6 is mentioned "a measure of wheat for a penny, and three measures of barley for a penny. This is supporting evidence, because Mercury was the god of trade. As to the
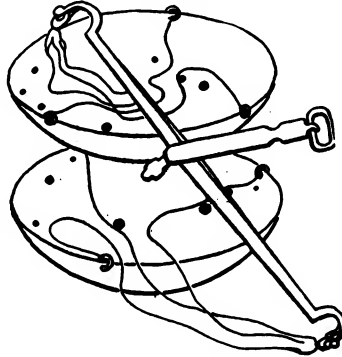
FIGURE 4 (LIBRA)

presence of the balances in his hand, there could be no doubt at all. There is only one constellation that is a pair of balances, and that is Libra. Therefore, in our interpretation we shall put it on record that:

> (3) At the time the Apocalypse was written, the planet Mercury was in the constellation of Libra.

Lastly, in Rev. 6:8 we read:

> And I looked and behold a pale horse, and his name that sat on him was Death and hell followed with him and power was given unto them over the fourth part of the earth to kill with swords, and with hunger and with death, and with the beasts of the earth.
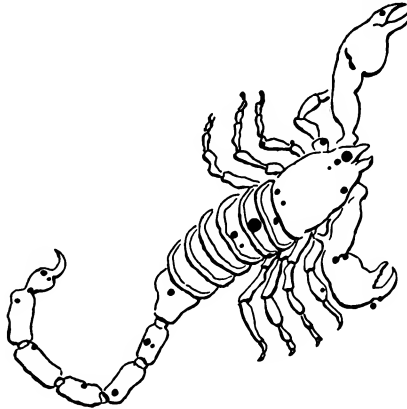
FIGURE 5 (SCORPIO)

We could see at a glance that the planet in question is Saturn. First of all because it is of a pale color, and secondly, because Saturn is a symbol of death. As to the constellation, it appears also to be a symbol of death, therefore to find them in conjunction should undoubtedly predict some

impending calamity.   Among all the constellations there is only one that could be considered as a symbol of death, namely, the constellation of Scorpio.   Therefore, in our interpretation we shall record that:

> (4) At the time the Apocalypse was written, the planet Saturn was in the constellation of Scorpio.

To sum up the above, the following conclusion suggests itself: If we could possibly, by means of astronomical calculations, determine the time when the four above-mentioned planets could be simultaneously found in the respective constellations, then the date when this chapter of the Apocalypse was written could be easily determined.

Now then, let us make an effort to see if there is any other useful information in some other chapters of the Apocalypse, that would refer to other heavenly bodies.

To our satisfaction we find two references of immense value. (1) In Rev. 1:9 we read:

> I was in the isle that is called Patmos.

Thus, the place of all observations is known.   Patmos Isle, is one of the Sporades Islands located in the Mediterranean Sea near Greece (37° 20′ N., 26° 33′ E.).

(2) The most important information we obtain from Rev. 12:1—

> . . . and there appeared a great wonder in Heaven.   A woman clothed with the Sun and the Moon under her feet . . .

FIGURE 6 (VIRGO)

There is only one constellation representing a woman, the constellation of Virgo, and since it is clearly stated that the Moon was under her feet, and that the woman was clothed with the Sun, it follows that the Sun

must have been somewhere not far away. Furthermore, in Rev. 14:14 and elsewhere a reference is made to a "sharp sickle," that was also observed in the sky. Could it possibly mean the crescent of a new moon? If so, then the sun would be found somewhere near the part of the constellation representing the leg of the woman. There is one star of the constellation, namely η Virgo, that is just above the ecliptic and is just on the leg of the woman, therefore it is likely that the Sun should be found somewhere not far from the star η Virgo.

(To be continued.)

Planet Notes for January, 1941

By R. S. ZUG

NOTE: Greenwich Civil Time is employed unless otherwise stated. To obtain Eastern Standard Time subtract 5 hours, Central Standard Time, 6 hours, etc. The planetary phenomena are described as they are to be seen from latitude 45° N. The data are taken chiefly from the *American Ephemeris and Nautical Almanac.*

Sun. Apparent positions of the sun for January 1 and 31, respectively, are: $\alpha = 18^h 44^m4$, $\delta = -23° 3'1$; $\alpha = 20^h 52^m8$, $\delta = -17° 32''7$. The sun's apparent motion takes it from the constellation of Sagittarius into the constellation Capricornus on January 19. On January 3 the earth will reach perihelion, and will attain its least distance from the sun.

Moon. Phenomena of the moon will occur as follows:

		h	m
First Quarter	Jan. 5	13	40
Full Moon	13	11	4
Last Quarter	20	10	1
New Moon	27	11	3
Apogee	Jan. 6	5	
Perigee	19	8	

Mercury. This planet reaches superior conjunction on January 11, after which it will be situated in the evening sky, but so near the sun as to be inconspicuous.

Venus. The elongation of Venus is decreasing so that the planet is becoming less conspicuous as a morning star. By the end of January the planet will rise less than an hour before sunrise. The stellar magnitude of Venus remains —3.3 during the month. The angular diameter of the planet is about 11", while over 90% of the visible disc will be seen illuminated by the sun's rays.

Mars. Mars will be seen during January as a morning star low in the southeastern sky. The planet will be moving eastward through the constellations Libra and Ophiuchus.

Jupiter. Jupiter will be moving slowly eastward through the constellation Aries during January. Eastern quadrature will occur on January 27. The stellar magnitude of the planet will be about —2.1.

Saturn. Saturn will be situated in Aries, about two degrees to the east of Jupiter, on January 1. The planet is in retrograde motion until January 10, when its apparent motion becomes direct. Jupiter will be drawing closer to Saturn dur-

ing the month, due to the more rapid easterly motion of the former. Saturn will reach eastern quadrature on January 28. An occultation of Saturn will occur January 7, invisible in the United States.

Uranus. Uranus will be in slow retrograde motion until January 30, when the motion becomes direct. The planet will be situated near the eastern boundary of the constellation Aries. Apparent position of the planet for January 1 and January 31, respectively, are: $\alpha = 3^h 20^m7$, $\delta = +18° 8'9$; $\alpha = 3^h 19^m2$, $\delta = +18° 4'0$.

Neptune. Neptune is to be found in the constellation Virgo. Apparent positions for January 1 and January 31, respectively, are: $\alpha = 11^h 53^m6$, $\delta = +2° 4'3$; $\alpha = 11^h 52^m6$, $\delta = +2° 12'3$.

Occultation Predictions

(Taken from the *American Ephemeris*)

Date 1941	Star	Mag.	Immersion Greenwich C.T.	a	b	Angle E from N	Emersion Greenwich C.T.	a	b	Angle E from N
			h m	m	m	°	h m	m	m	°
Occultations Visible in Longitude +72° 30', Latitude +42° 30'										
Jan. 3	263 B.Aqr	6.2	0 29.2	—0.9	—0.6	72	1 38.3	—0.4	—0.5	242
11	115 Tau	5.3	0 8.8	—1.2	+1.9	70	1 27.6	—1.8	+0.5	274
11	124 H¹ Ori	5.7	20 46.5	+0.5	+1.9	53	21 32.6	—0.2	+0.6	298
11	292 B.Ori	6.5	23 56.9	—1.2	+0.5	114	1 2.2	—1.1	+2.1	240
15	222 B.Cnc	6.3	5 2.3	—1.9	+0.7	90	6 17.7	—1.6	—1.4	309
16	43 Leo	6.3	11 19.2	—0.7	—1.6	113	12 21.1	—0.3	—1.7	290
17	75 Leo	5.4	11 43.1	—0.3	—3.0	166	12 22.3	—1.1	—0.5	240
22	θ Lib	4.3	10 10.5	—1.5	+0.9	94	11 24.6	—1.5	—0.2	299
Occultations Visible in Longitude +91° 0', Latitude +40° 0'										
Jan. 3	263 B.Aqr	6.2	0 6.8	—1.4	+0.2	60	1 25.8	—1.2	—0.4	248
10	115 Tau	5.3	23 49.3	—0.4	+2.2	59	0 54.9	—1.3	+0.7	282
11	292 B.Ori	6.5	23 41.1	—0.4	+0.9	104	0 41.6	—0.5	+1.8	247
12	26 Gem	5.1	11 40.2	—0.6	+1.0	33	12 1.8	+1.1	—3.5	345
15	222 B.Cnc	6.3	4 32.3	—1.3	+0.6	105	5 47.7	—1.6	+0.1	287
16	43 Leo	6.3	11 8.1	—0.9	—2.1	137	12 12.4	—1.1	—1.3	271
22	θ Lib	4.3	9 51.4	—0.5	+0.3	121	10 57.2	—1.2	+0.9	273
Occultations Visible in Longitude +120° 0', Latitude +36° 0'										
Jan. 1	72 B.Aqr	6.5	2 26.7	—0.8	—0.4	70	3 33.0	—0.4	—0.5	247
2	ρ Aqr	5.4	3 51.3	—0.6	—0.4	67	4 55.1	—0.2	—0.5	249
10	115 Tau	5.3	23 44.0	+0.6	+2.4	38	0 25.9	—0.5	+0.1	304
11	130 Tau	5.5	11 44.8	+0.9	—4.4	162	12 8.7	—1.1	+1.8	209
12	26 Gem	5.1	11 22.9	—0.8	—0.9	84	12 23.8	—0.1	—1.9	298
15	222 B.Cnc	6.3	4 8.3	—0.3	+0.5	110	5 9.2	—0.6	+1.0	272
23	29 Oph	6.4	14 36.8	—0.7	—1.7	154	15 25.0	—2.6	+2.3	228

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

Occultation Observations.—The *Harvard College Observatory Announcement Card* 547 contains the following quotation from Dr. Dick Brouwer of Yale Observatory:

"War conditions have greatly reduced the supply of occultations from Europe. An appeal is therefore made to observers who are in a position to continue these observations."

Comet Notes
By G. VAN BIESBROECK

COMET 1940 *d* ('CUNNINGHAM). Of the various comets announced last month only one comes in reach of ordinary telescopes. As foreseen, Comet Cunningham has increased considerably in brightness since it was first photographed on August 15.
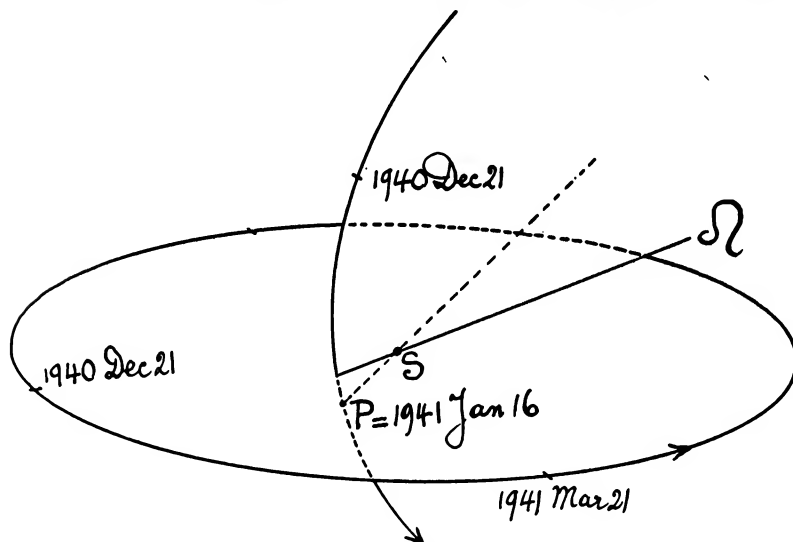
FIGURE 1
ORBIT OF COMET CUNNINGHAM.

Figure 1 shows the relative position of the earth, describing its yearly orbit around the sun *S*, and the comet passing from the north to the south in January and reaching its minimum distance from the sun at *P* on January 16, 1941, when it will also reach its maximum brightness and physical activity. So far the general appearance has not changed much except for the increase in brightness. Figure 2 is enlarged from a 20-minute exposure with the 82-inch reflector at the McDonald Observatory on November 1. The sharp stellar nucleus is not visible in the overexposed coma but the broad and somewhat dissymmetrical tail is visible over a length of about 8' from that point. The distance from the sun was 1.7 astronomical units at that time. A very much greater development of the tail is expected in December when the comet comes well within the earth's orbit. The following ephemeris computed by the discoverer, Mr. L. E. Cunningham, (*Harv. Ann. Card* 543) will help in locating the comet until it rapidly disappears in the southern hemisphere:

FIGURE 2
COMET CUNNINGHAM, 1940 NOVEMBER 1.
(Scale 1 in. = 3ʹ2.)

1940 0ʰ U.T.	α (1940.0) δ			—Distance from—		Magn.
	h m s	° ʹ		earth	sun	
Dec. 1	19 18 24	+29 46.0		1.14	1.16	8.0
5	20 27	28 7.1		1.09	1.08	7.6
9	28 48ˉ	26 21.9		1.04	1.01	7.2
13	25 21	24 25.3		0.98	0.93	6.7
17	27 59	22 12.4		0.93	0.85	6.2
21	30 35	19 33.6		0.86	0.77	5.6
25	32 54	16 14.3		0.80	0.69	5.0
29	19 34 37	+11 52.2		0.73	0.61	4.2
1941	(1941.0)					
Jan. 2	19 35.3	+ 5 54		0.67	0.64	3.5
6	34.3	— 2 19		0.62	0.47	2.7
10	31.5	12 58		0.59	0.41	2.0
14	19 27.6	—24 35		0.61	0.37	1.7

The apparent motion is almost straight south. On December 30 the comet will pass two degrees west of Altair and be well visible to the naked eye. But the actual brightness cannot be foreseen at this time. In most comets the brightness varies roughly inversely as the 4th power of the distance from the sun, which law has been used in computing the last column "magnitude" of the ephemeris. Sometimes the change is even greater and that would make the maximum brightness more intense. It will be of interest to watch not only the brightness but also other physical changes, such as the extent of the tail as the comet moves southward and

is lost in the glare of the sun in the middle of January. Southern observers will have the best chance to see the comet in its full development.

COMET 1940 *f* (OKABAYASI) has followed the northeastward course indicated by the first announcement. From short arcs of observation the following preliminary orbits have been computed:

	Miss Scott (Berkeley)	Maxwell and Wood
Perihelion passage	1940 Aug. 11.979	1940 Aug. 13.618
Node to perihelion	320° 40′	325° 2′0
Longitude of node	125 59	126 35.5
Inclination	131 25	132 14.4
Perihelion distance	0.9730	1.0175

The comet moves in a highly inclined retrograde orbit. It is well situated but has lost rapidly in brightness so that it is only in reach of large telescopes. Figure 3

FIGURE 3
COMET OKABAYASI, 1940 OCTOBER 29.
(Scale 1 in. = 1′.8.)

shows the appearance on a 16-minute exposure taken at the prime focus of the 82-inch reflector of the McDonald Observatory on October 29. It shows a stellar nucleus surrounded by a faint coma extending into a short tail.

Little is to be added concerning periodic comets Schwassmann-Wachmann and Whipple which remain faint and will soon be lost in the evening twilight.

Williams Bay, Wisconsin, November 11, 1940.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society
By CHARLES P. OLIVIER, President

In the October Meteor Notes was given a full description of the attempt made by groups occupying stations near Philadelphia to observe the Perseids for heights. When I published this I had great hopes that we would secure from 20 to 40 heights, but many hours of hard work have proved this an unwarranted expectancy. It is needless here to recapitulate all the reasons why we failed in our rather

ambitious plans, but I feel it only just to say I should take the major blame, as it was primarily loose organization which was at fault. In addition to this, simple bad fortune and misunderstandings of instructions played considerable rôles. Also far the larger number of observers were trying the plotting of meteors for the first time. Fortunately, most of the errors are easy to remedy in future work, and three of the same groups of amateurs were out to observe the Orionids, from stations distant from one another. Examination of these later records indicates that their reduction will be far easier and should yield more numerous and valuable results than did those of last August which we are discussing here.

Briefly, I find 8 meteors for which I have deduced heights. There are several other coincidences, but the small parallactic angles make their reduction useless, and therefore they were not attempted. My own observations unfortunately could not be used except in two cases as I observed to S.W. to get coincidences with our Baltimore observers. Unfavorable conditions there ruined their coöperation, and hence most of my own work fitted in with none of the rest. The general experience emphasized the absolute necessity of trying to get the time of a meteor's appearance to the nearest second or two. And also that each observer should strictly keep watch on the particular region of sky assigned to him. Those results which we obtained, all on 1940 August 10-11, follow:

TABLE

Meteor	E.S.T. h m	Beginning km	End km	Class	Magn.	Observers
1	12:16	130 ± 13	105 ± 21	P, P, P	—, 1, 1	R, G2, C
2	12:31	127 ± 42	83 ± 11	P, P, S	—, 1, 0	R, G2, S
3	12:40	101 ± 13	....	P?, S	1, 4	G2, S
4	13:17	146 ± 1	142 ± 14	S?, P, P	—, 3, 2	R, Ol, T
5	13:36	89 ± 12	78 ± 4	S, P	—, 2	R, G2
6	14:02	100 ± 10	95 ± 8	S?, P?	—, 2	R, G2
7	14:31	122 ± 23	104 ± 21	P, S?	—, 3	R, T
8	14:49	116	106 ± 12	P, P	4, 1	Ol, G2

Note: Observers were   Station (near)

R = Rosengarten ....West Creek, New Jersey
C = Cope ....Doylestown, Pennsylvania
T = Thompson ....Cook Observatory, Pennsylvania
S = Miss L. M. Smith............................Milton, Pennsylvania
Ol = Olivier ....Doylestown, Pennsylvania
G2 = Group 2 Amateur Astr. Franklin Inst........Fox Chase, Pennsylvania

While I naturally should wish that we had secured more data, yet the reasons for partial failure are obvious enough and, as said, have already been largely cured by our observers. Coöperative work for heights is strongly recommended to groups of observers in the same state, and I hope that many will undertake it in 1941. It is one of the most useful kinds of meteor work and trains an observer in accuracy faster than any other an amateur is ever likely to undertake.

Flower Observatory of the University of Pennsylvania,
Upper Darby Pennsylvania, 1940 November 11.

Contributions of the
Society for Research on Meteorites

Edited by FREDERICK C. LEONARD,
Department of Astronomy, University of California, Los Angeles

President of the Society: H. H. NININGER, Colorado Museum of Natural History and American Meteorite Laboratory, Denver
Secretary of the Society: ROBERT W. WEBB, Department of Geology, University of California, Los Angeles

Third Catalog of Meteoritic Falls (S.R.M. Nos. 183-321) Reported to the Society for Research on Meteorites: January, 1939, to October, 1940

By ADDIE D. NININGER,
American Meteorite Laboratory, Denver, Colorado,
Chairman of the Committee on Catalog of the S.R.M.

[The falls following are listed alphabetically by countries and are numbered provisionally in continuation of those contained in the second S.R.M. catalog, *C.S.R.M.*, **2**, No. 2, 96-101; *P.A.*, **47**, 209-14, 1939.]

S.R.M. No.   UNITED STATES

183. Aiken, Floyd Co., Texas. Stone; fnd. 1936; wt. 956 g. One stone. Rep. A. M. L.
184. Akron, Washington Co., Colorado. Stone; fnd. 1940; wt. 407 g. preserved from a mass of 4 to 7 kg. (10 to 15 lb.). Rep. A. M. L.
185.* Alexander Co., North Carolina. Iron; fnd. 1860; original wt. not given. One mass. Rep. U. S. N. M.
186.* Aragon, Polk Co., Georgia. Iron; fnd. 1898; wt. 5 g. 2 frags. Rep. U. S. N. M.
187. Argonia, Sumner Co., Kansas. Pallasite; fnd. many years ago; recently identified; wt. about 84 g., preserved from a mass estimated to have weighed 34 kg. (75 lb.). Rep. A. M. L.
188. Aztec, San Juan Co., New Mexico. About 30 mi. south of Aztec. Stone; fell 1938 Feb. 1, about 5 P.M.; wt. 2.83 kg. (6.33 lb.). One stone. Rep. A. M. L.
189.* Blackwell, Kay Co., Oklahoma. Stone; fell 1906 May [day?], about 9 P.M., wt. 2.38 kg. (5.2 lb.). One stone. Rep. U. S. N. M.
190. Bushnell, Kimball Co., Nebraska. Sec. 25, Tp. 15, R. 59. Stone; fnd. 1939, wt. 1240 g. One stone. Rep. A. M. L.
191.* Campbellsville, Taylor Co., Kentucky. Iron; fnd. 1929; wt. 15.04 kg. (33.92 lb.). One mass. Rep. Univ. of Kentucky.
192. Camp Verde, Yavapai Co., Arizona. Iron; fnd. about 1915; rec. 1939; wt. 61.5 kg. (135.5 lb.). One mass. Rep. A. M. L.
193. Canyon Diablo, Coconino Co., Arizona, No. 2. Iron; rec. 1936; wt. 810 g. 4 irons. Rep. A. M. L.
194. Cedartown, Polk Co., Georgia. Iron. Date of fall or find unknown; wt. 11.3 kg. (25 lb.). One mass. Rep. U. S. N. M.
195. Concho, Glasscock Co., Texas. Stone; rec. 1939; wt. 93.5 kg. (206 lb.). One mass. Rep. Univ. of Texas.
196. Davy, DeWitt Co., Texas. Stone; rec. 1940; wt. about 45 kg. (100 lb.). One mass and numerous frags. Rep. O. E. Monnig.
197. Densmore, Norton Co., Kansas. W. 99° 41', N. 39° 39'. Stone; fnd. 1879; rec. 1939; wt. 37.2 kg. (81.8 lb.). 3 frags. Rep. George Sternberg.
198. Fleming, Logan Co., Colorado. Stone; fnd. 1940; wt. 1.75 kg. (3.85 lb.). One stone. Rep. A. M. L.
199. Ganado, Apache Co., Arizona. Iron; fnd. 1938; wt. 38.9 g. One mass. Rep. A. M. L.

200.* Glasgow, Barren Co., Kentucky. Iron; fnd. 1922; wt. 20.3 kg. (44.7 lb.). 2 masses. Rep. George P. Merrill.

201. Goose Lake, Modoc Co., California. W. 120° 32.5, N. 41° 58.6. Iron; fnd. 1938 Oct. 13; wt. 1167 kg. (2573 lb.). One mass. Rep. S. R. M. expedition.

202. Hat Creek, Niabrara Co., Wyoming. W. 104° 25', N. 42° 53'. Stone; fnd. 1939; wt. 8.9 kg. (19.6 lb.). One stone. Rep. A. M. L.

203.* Helt Tp., Vermillion Co., Indiana. Iron; fnd. 1915; wt. 218.5 g. One mass. Rep. S. H. Perry.

204. Horace, Greeley Co., Kansas. W. 101° 46', N. 38° 21'. Stone; fnd. 1940; wt. 9.2 kg. (20.2 lb.). One stone. Rep. A. M. L.

205. Howe, Grayson Co., Texas. Stone; rec. 1938; wt. 8.63 kg. (18.99 lb.). One stone. Rep. A. M. L.

206. Indianola, Red Willow Co., Nebraska. Sec. 2, Tp. 2. Stone; fnd. 1939; wt. 4 kg. (8.8 lb.). One stone. Rep. A. M. L.

207. Kendleton, Harris Co., Texas. W. 95° 15' 44", N. 29° 41' 6". Stone; fell 1939 May 2, 7:25 P.M.; wt. 6.93 kg. (15.25 lb.). 13 inds., 15 frags. Rep. O. E. Monnig.

208.* Kingston, Sierra Co., New Mexico. Iron; fnd. 1891; wt. 12.9 kg. (28.5 lb.). One mass. Described by Hovey, 1912.

209.* Lanton, Howell Co., Missouri. Iron; fnd. 1932 July; wt. 13.78 kg. (30.3 lb.). 4 frags. Rep. Missouri School of Mines.

210.* La Porte, La Porte Co., Indiana. Iron; fnd. 1900; wt. 14.54 kg. (32 lb.). 4 frags., largest weighing 11.56 kg. (25.5 lb.). Rep. Field Mus. of Nat. Hist.

211. Lubbock, Lubbock Co., Texas. W. 101° 51', N. 33° 35'. Stone; fnd. 1938 Nov. 28; wt. 1.45 kg. (3.2 lb.). Rep. Texas Tech. Coll.

212. Lusk, Niabrara Co., Wyoming. Iron (oxidized); fnd. 1940; wt. undetermined. One frag. Rep. A. M. L.

213. Mapleton, Monona Co., Iowa. Iron; fnd. 1939 June 17; wt. 49.09 kg. (108 lb.). One mass. Rep. Field Mus. of Nat. Hist.

214. McAddo, Dickens Co., Texas. Stone; fnd. 1935; wt. 1100 g. One stone. Rep. West Texas Mus.

215. McLean, Gray Co., Texas. Stone; fnd. 1939; wt. 4.3 kg. (9.5 lb.). One stone. Rep. A. M. L.

216. Naruna, Burnet Co., Texas. Stone; fnd. 1935; rec. 1939; wt. 672 g. One stone. Rep. O. E. Monnig.

217. Nashville, Nash Co., North Carolina. Iron; fnd., date unknown; wt. 2.574 kg. (5.66 lb.). One mass and frags. Rep. U. S. N. M.

218. Newsom, Alamosa Co., Colorado. Stone; fnd. 1939; wt. 892 g. One stone. Rep. A. M. L.

219.* Newtown, Fairfield Co., Connecticut. Iron; fell 1925 Dec. 29; wt. 215.6 g. One mass. Rep. U. S. N. M.

220.* Oktibbeha Co., Mississippi. Iron; fnd. about 1854; wt. 156 g. One mass. Rep. U. S. N. M.

221. Ovid, Sedgwick Co., Colorado. Stone; fnd. 1939; wt. 6.169 kg. (13.67 lb.). One stone. Rep. A. M. L.

222. Ozona, Crockett Co., Texas. Stone; fnd. 1929; rec. 1939; wt. 127.5 kg. (281 lb.). Several frags., largest, 45 kg. (100 lb.). Rep. Texas Coll. of Mines.

223.* Paulding Co., Georgia. Iron; fnd. about 1901; wt. 725 g. One mass. Rep. U. S. N. M.

224.* Pickens Co., Georgia. Stone; fnd. 1908; wt. 400 g. One stone. Rep. U. S. N. M.

225. Pierceville, Finney Co., Kansas. Tp. 26, R. 31 W. Stone; fnd. 1939; wt. 2.125 kg. (4.67 lb.). One stone. Rep. A. M. L.

226.* Pine River, Waushara Co., Wisconsin. W. 89° 5', N. 44° 8'. Iron; fnd. 1931; wt. 3.6 kg. (8 lb.). One mass. Rep. U. S. N. M.

227.* Providence, Trimble Co., Kentucky. Iron; fnd. 1903; wt. 6.805 kg. (14.968 lb.). One mass. Rep. Univ. of Kentucky.

228. Rolla, Morton Co., Kansas. Stone; rec. 1938. Undescribed. Rep. U. S. N. M.

229. Romero, Hartley Co., Texas. Stone; fnd. 1939; wt. about 17.2 kg. (38 lb.). One stone. Rep. A. M. L.

230.* Rosebud, Milam Co., Texas. Stone; fnd. 1907; wt. 54.9 kg. (121.25 lb.). One

stone. (Identical with "Glen Rose," listed in H. H. Nininger's *Our Stone-Pelted Planet,* App., p. 163, 1933.)

231. Round Top, Fayette Co., Texas. Stone; fnd. 1934; rec. 1937; wt. 7.7 kg. (17 lb.). One stone. Rep. O. E. Monnig.

232.* Salina, Sevier Co., Utah. Iron; fnd. 1908; wt. 235 g., preserved. One frag., oxidized scale. Rep. S. H. Perry.

233. Sanderson, Terrell Co., Texas. Iron; fnd. 1936 Mar.; wt. 6.8 kg. (15 lb.). One mass. Rep. Texas Coll. of Mines.

234. Silverton, Briscoe Co., Texas. Stone; fnd. 1938; wt. 1.37 kg. (3.03 lb.). One stone. Rep. O. E. Monnig.

235. Washougal, Clark Co., Washington. N. E. corner of Sec. 8, Tp. 1 N., R. 4 E. Stone; fell 1939 July 2, 7:58 A.M.; wt. 220 g.±. One stone. Rep. J. Hugh Pruett.

236. Waterville, Douglas Co., Washington. 16 mi. N. W. of Waterville. Iron; fnd. before 1929; wt. 34 kg. (75 lb.). One mass. Rep. Coll. of Puget Sound.

237. Wickenburg, Maricopa Co., Arizona, No. 1. 3 mi. W. of Wickenburg. Stone; rec. 1940; wt. 9.2 kg. (20.25 lb.). One stone. Rep. A. M. L.

238. Wickenburg, Maricopa Co., Arizona, No. 2. Iron; rec. 1940; wt. 250 g. One mass. Rep. A. M. L. (Possibly identical with Canyon Diablo.)

239.* Zaffra, La Flore Co., Oklahoma. Iron; fnd. 1919; wt. 3 kg. (6.6 lb.). One mass. Rep. U. S. N. M.

S.R.M. No.   CANADA

240. Dresden, Ontario, Canada. W. 82° 15', N. 42° 31'. Stone; fell 1939 July 12, 8:49 P.M.; wt. 47.7 kg. (105 lb.). 3 stones. Rep. P. M. Millman.

241. Edmonton, Alberta, Canada. Iron; rec. 1939; wt. 7.34 kg. (16.16 lb.). One mass. Rep. P. M. Millman.

242. Great Bear Lake, Northwest Territories, Canada. Stone; fnd. 1936; wt. 13½ g. Rep. U. S. N. M.

S.R.M. No.   SOUTH AMERICA

243. Antofagasta, Chile. Pallasite. Known 1938. Undescribed. Rep. U. S. N. M.

244.* Barbacena, Minas Geraes, Brazil. Iron; fnd. 1918 Mar.; wt. 9.026 kg. (19.857 lb.). 2 masses. Rep. U. S. N. M.

245.* Cerros del Buei Muerto, Dept. Tocopolla, Chile. W. 69° 9', S. 22° 5'. Iron; fnd. 1937; wt. 75 kg. (165 lb.). One mass. Rep. U. S. N. M.

246.* Hinojo, Buenos Aires, Argentina. Stone; undescribed. Rep. P. M. Millman.

247.* Isthilart, Concordia, Argentina. Stone; fell 1928 Nov. 12. Rep. P. M. Millman.

248.* Piedade do Bagre, Minas Geraes, Brazil. W. 45°, S. 18° 9'. Iron; fnd. 1922. Rep. P. M. Millman.

249.* Renca, San Luis, Argentina. Stone; fell 1925 June 20; wt. 300 g. One stone. Rep. P. M. Millman.

250.* Rio Loa, Chile. Iron; fnd. about 1915; wt. 4 kg. (8.8 lb.). One mass. Rep. U. S. N. M.

251.* San Martin, Chile. Iron; undescribed. Rep. U. S. N. M.

252.* Sierra Gorda, Chile. Iron; fnd. about 1898. Rep. U. S. N. M.

S.R.M. No.   AFRICA

253.* Air, Nigeria, Africa. Stone; fell 1925; wt. 24 kg. (52.8 lb.). 2 stones. Rep. U. S. N. M.

254.* Birni N'Konni, Niger Colony, French West Africa. E. 5° 3', N. 13° 8'. Stone; fnd. 1923; wt. 560 g. 3 stones. Rep. U. S. N. M.

255.* Bowden, Cape Province, South Africa. Stone; fnd. 1907; wt. 603 g. One stone. Rep. U. S. N. M.

256.* Khor-Temiki, Kassala, Sudan. Stone; fell 1932 Apr. 8; wt. 3.18 kg. (7 lb.) recovered. Rep. Brit. Mus. of Nat. Hist.

257. Macibini, Zululand, Africa. E. 31° 55', S. 28° 51'. Stone; fell 1936 Sep. 23, 8:00 A.M.; wt. 2 kg. (4.4 lb.). 4 complete stones, 2 frags. Rep. L. J. Spencer.

258.* Naifa, Suwahib Desert, Africa. Iron; fnd. 1932 Mar. 4; wt. 8 g. One mass. Rep. U. S. N. M.

259. Tanesrouft, Algeria. Stone; fnd. 1936 Feb. 12; wt. 5.174 kg. (11.38 lb.). One stone. Rep. U. S. N. M.
260.* Tataouine, South Tunis, Tunisia, Africa. Stone; fell 1931 June 27, 1:30 P.M.; wt. 12 kg. (26.4 lb.). A number of broken frags. Rep. U. S. N. M.
261.* Udei Station, Nigeria, Africa. Mesosiderite; fell 1927; wt. 102.6 kg. (226 lb.). Rep. Brit. Mus. of Nat. Hist.
262.* Witsand Farm, Southwest Africa. Stone; fell 1932 Dec. 1, 5:00 P.M.; wt. 80 g., preserved. Rep. Brit. Mus. of Nat. Hist.

S.R.M. No.   AUSTRALIA

263.* Australia, location unknown. Pallasite; fnd. 1880; wt. a few lb., preserved. Rep. R. Bedford.
264.* Bencubbin, Western Australia. Pallasite; fnd. 1930 July 30; wt. 54 kg. (119.5 lb.). One mass. Rep. U. S. N. M.
265.* Coolac, New South Wales, Australia. Iron; fnd. 1874; wt. 19.25 kg. (42.35 lb.). One mass. Rep. R. Bedford.
266.* Dalgaranga, West Australia. Iron; fnd. 1923; wt. only 40 g., preserved. Rep. R. Bedford.
267.* Dowerin, West Australia. Iron; fnd. 1928; wt. unknown. A large number of frags. Rep. R. Bedford.
268.* Glenormiston, Queensland, Australia. Iron; fnd. 1925; wt. 40.82 kg. (90 lb.). One mass. Rep. U. S. N. M.
269. Gundaring, West Australia. Iron; fnd. 1927; wt. 112.5 kg. (247.5 lb.). One mass. Rep. R. Bedford.
270. Huckitte, Central Australia. Pallasite; fnd. 1937; wt. 2 tons. One mass. Rep. R. Bedford.
271. Kumerina, West Australia. Iron; fnd. 1937; wt. 53.5 kg. (117.7 lb.). One mass. Rep. R. Bedford.
272.* Landor, West Australia. Iron; fnd. 1931; wt. about 9 kg. (19.8 lb.). One mass. Rep. R. Bedford.
273.* Mallenbye, West Australia. Iron; fnd. 1929; wt. 337 g. One frag. Rep. R. Bedford.
274. Wonyulgunna, West Australia. Iron; fnd. 1937; wt. 37.8 kg. (82.16 lb.). One mass. Rep. R. Bedford.
275. Yalgoo, West Australia. Stone; known before 1937; wt. 850 g. One stone. Rep. R. Bedford.

S.R.M. No.   CHINA AND MONGOLIA

276.* Liweipantsun, Eastern Kiangsi, China. Stone; fell 1931 Aug. 27, 3:00 P.M.; wt., largest of 10 stones, 4.8 kg. (10.56 lb.). Rep. U. S. N. M.
277.* Nanseiseki, Shantung, China. Pallasite; fell 1920 Aug. 13; wt. unknown. Rep. P. M. Millman.
278.* Tschinga, Upper Yenisei, Mongolia. Iron; fnd. 1913; wt. unknown. Many masses. Rep. U. S. N. M.

S.R.M. No.   MEXICO

279.* Ameca Ameca, Mexico. W. 98° 40', N. 19° 5'. Iron; described 1889; wt. not recorded. Rep. Geol. Institute of Mexico.
280.* Los Reyes, Mexico. W. 98° 50', N. 19° 10'. Iron; fnd. 1897; wt. 19.5 kg. (43 lb.). One mass. Rep. Geol. Institute of Mexico.
281. Santa Cruz, Tamaulipas, Mexico. W. 99° 20', N. 24° 10'. Stone; fell 1939 Sep. 3, midday; wt. unknown. Several stones. Rep. Geol. Institute of Mexico.

S.R.M. No.   JAPAN AND KOREA

282.* Aba, Inasiki, Ibavaki, Japan. Stone; fell 1927 Apr. 28; wt. 0.2 g. One stone. Rep. Tokyo Astr. Obs.
283.* Gyokukei, Keisyô-hokudô, Korea. Stone; fell 1930 Mar. 17; wt. 1.32 kg. (2.9 lb.). Rep. Tokyo Astr. Obs.
284.* Hukuye, Gotô, Nagasaki, Japan. Iron; fell 1842 Feb.; wt. 8 g. One mass. Rep. Tokyo Astr. Obs.
285. Kasamatu, Hazima, Gihu, Japan. Stone; fell 1938 Mar. 31; wt. 0.71 kg. One stone. Rep. Tokyo Astr. Obs.

286.* Kizima, Simotakai, Nagano, Japan. Pallasite(?); fell 1906 June 15; wt. 0.331 kg. 2 masses. Rep. Tokyo Astr. Obs.

287.* Kusiike, Nakakubiki, Niigata, Japan. Stone; fell 1920 Sep. 20; wt. 4.5 kg. (9.9 lb.). One stone. Rep. Tokyo Astr. Obs.

288.* Numakai, Isikari, Hokkaidô, Japan. Stone; fell 1925 Sep. 5; wt. 0.363 kg. One stone. Rep. Tokyo Astr. Obs.

289.* Sakauti, Ibi, Gihu, Japan. Iron; fnd. 1913; wt. 4.18 kg. (10.29 lb.). One mass. Rep. Tokyo Astr. Obs.

290.* Siroiwa, Senboku, Akita, Japan. Stone; fnd. 1920; wt. 0.95 kg. One stone. Rep. Tokyo Astr. Obs.

291.* Suwa, Nagano, Japan. Iron; fnd. before 1915.; wt. 0.203 kg. One mass. Rep. Tokyo Astr. Obs.

292.* Tane, Higasi-asai, Siga, Japan. Stone; fell 1918 Jan. 25; wt. 0.906 kg. 2 stones. Rep. Tokyo Astr. Obs.

293.* Tomita, Asaguti, Okayama, Japan. Stone; fell 1916 Apr. 13; wt. 0.60 kg. One stone. Rep. Tokyo Astr. Obs.

294.* Unkoku, Zenra-nandô, Korea. Stone; fell 1924 Sep. 7; wt. 0.85 kg. One stone. Rep. Tokyo Astr. Obs.

S.R.M. No.   MISCELLANEOUS

295.* Ain Sala, Suwahib Desert, Arabia. Stone; fnd. 1932 Feb. 10; wt. 106.7 g. 3 pieces. Rep. U. S. N. M.

296. Bettrechies, Dept. Nord, France. Stone; fell 1934 Nov. 26, 8-9 P.M.; wt. estimated 15-20 kg. (33-44 lb.). One stone. Rep. U. S. N. M.

297.* Beyrouth, Syria. Stone; fell 1921 Dec. 31, 3:45 P.M.; wt. 1100 g. One stone. Rep. U. S. N. M.

298.* Buwah, Suwahib Desert, Arabia. E. 51° 4', N. 20° 1'. Stone; fnd. 1931 Jan. 14; wt. 241 g. One stone. Rep. U. S. N. M.

299.* Chavez, Tras-os-Montes, Portugal. Stone; fell 1925 May 3; wt. 2.67 kg. (5.87 lb.). One stone. Rep. U. S. N. M.

300.* Drevdalen, Trysil, Norway. Stone; fell 1927 June 21, 6:00 A.M.; wt. 640 g. One stone. Rep. U. S. N. M.

301. Dyarrl Island, New Guinea. Pallasite; fell 1933 Jan. 31, 4:30 P.M.; wt. 170 g., recovered. Rep. U. S. N. M.

302. Ekeby, Skåne, Sweden. Stone; fell 1939 Apr. 5, 6ʰ 12ᵐ G.M.T.; wt. 3.31 kg. (7.28 lb.). One stone. Rep. Obs., Lund.

303.* Magnesia, Asiatic Turkey. Iron; fell 1899; wt. 5 kg. (11 lb.). One mass. Rep. Brit. Mus. of Nat. Hist.

304. Nassira, New Caledonia, South Sea Islands. Stone; fell 1936 July 15, 4:30 P.M.; wt. 342 g. 2 frags. Rep. U. S. N. M.

305.* Oteroy, Oter Island, Norway. Stone; fell 1928 Oct. 15, 3:00 P.M.; wt. 220 g. frags., collected. Rep. U. S. N. M.

305.* Padvarninkai, Lithuania. E. 28° 4', N. 55° 7'. Stone; fell 1929 Feb. 9, 12:45 A.M.; wt. 3.858 kg. (8.487 lb.). 11 stones. Rep. U. S. N. M.

306.* Rembang, Java. Iron; fell 1919 Aug. 30; wt. 10 kg. (22 lb.). One mass. Rep. R. Bedford.

307.* Sedikoy, Smyrna. Stone; fell 1917; wt. unknown. Rep. Brit. Mus. of Nat. Hist.

308.* Sopot, Dolj, Rumania. Stone; fell 1927 Apr. 27; wt. 958 g. 8 frags. Rep. U. S. N. M.

309.* Tauq, Iraq. Stone; fell 1929; wt. about 6 kg. (13.2 lb.). Rep. Brit. Mus. of Nat. Hist.

310.* Umm Tina, Suwahib Desert, Arabia. Stone; fnd. 1932 Feb. 20; wt. 70.2 g. About a dozen frags. Rep. U. S. N. M.

S.R.M. No.   RUSSIA AND SIBERIA (U. S. S. R.)

311.* Boriskino, Samara, U. S. S. R. Stone; fell 1930 Apr. 20, 13ʰ 30ᵐ; wt. 1156.6 g. 2 stones. Rep. P. M. Millman.

312. Kainsas, Muslium, Tartar Republic, U. S. S. R. Stone; fell 1937 Sep. 14; wt. over 200 kg. (440 lb.). 15 stones. Rep. P. M. Millman.

313. Kaptal-Aryk, Kalinin, Kirghizian Republic, U. S. S. R. Stone; fell 1937 May 12; wt. 35 kg. (77 lb.). One stone. Rep. P. M. Millman.

314. Komarinsk District, White Russia. Iron; fnd. 1937; wt. unknown. Rep. P. M. Millman.
315. Kukschin, Cherinigov Region, Ukraine. E. 31° 50′, N. 51° 3′. Stone; fell 1938 June 11; wt. 2262.5 g. One stone. Rep. P. M. Millman.
316. Lawrentjevka, Andreevskogo District, Orenburg Province, U. S. S. R. E. 51° 34′, N. 52° 37′. Stone; fell 1938 Jan. 11, 9ʰ 30ᵐ G.C.T.; wt. 793.60 g. 5 pieces. Rep. P. M. Millman.
317.* Novorybinskoe, Kazakhstan, U. S. S. R. E. 71°15′, N. 51° 53′. Iron; fell probably 1927; wt. 3055 g. Rep. L. J. Spencer.
318.* Orlovka, Siberia, U. S. S. R. Stone; fnd. 1928; wt. 40 kg. (88 lb.). One stone. Rep. U. S. N. M.
319. Pavlodar, Kazakhstan, Siberia, U. S. S. R. W. 77°, N. 52½°. Stone; fell 1933 May 23, 1:40 P.M.; wt. 142.5 g. One stone, 4 frags. Rep. L. J. Spencer.
   Note: The Pavlodar, Semipalatinsk, Siberia, U. S. S. R., pallasite, found in 1885, is now called "Yamysheva" in the U. S. S. R. list.
320.* Tyumen, West Siberia, U. S. S. R. E. 65° 32′, N. 57° 10′. Iron; fell 1903 Apr.; wt. 0.75 kg. One fragment. Rep. L. J. Spencer.
321. Zhovtnevy, Marjinskogo District, Stalin Region, U. S. S. R. E. 37° 15′, N. 47° 35′. Stone; fell 1938 Oct. 9, 0ʰ G.C.T.; wt. 54 kg. (118 lb.)±. 4 stones broken into many pieces. Rep. Acad. of Sci., U. S. S. R.

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*Starred falls were omitted from the two earlier catalogs.

ABBREVIATIONS USED IN THE CATALOG

A. M. L. = American Meteorite Laboratory (Denver, Colorado).
Fnd. = found.
Frags. = fragments.
Inds. = individuals.
Rec. = recognized.
Rep. = reported by.
U. S. N. M. = United States National Museum (Washington, D. C.).
Wt. = weight.

NOTE

The Society for Research on Meteorites requests all students of meteorites throughout the world, especially those professionally connected with recognized institutions of learning, research laboratories, museums, *etc.*, to report promptly and directly all new meteoritic falls or discoveries to the compiler of this catalog, who is the Chairman of the Committee on Catalog of the S. R. M., American Meteorite Laboratory, 635 Fillmore St., Denver, Colorado, so that they may receive credit for their reports in our regularly published catalogs. Individual collectors and students who submit convincing evidence of newly reported falls likewise will be recognized and credited. Samples of material may be submitted as evidence of the authenticity of a report.

Inclusions In an Admire, Kansas, Pallasite
By JOHN DAVIS BUDDHUE,
99 S. Raymond Av., Pasadena, California

The inclusions herein described were detected in only one of two thin sections of the olivine from one of the meteorites (pallasites), found about 1890 near Admire, Lyon Co., Kansas. These inclusions do not appear in the plates accompanying Merrill's description of the Admire meteorites.[1] Since the inclusions appear in only a part of one thin section, it seems probable that they have only a restricted occurrence in these meteorites. Moreover, I have not heard of any inclusions like them in any other meteorite. They may be described as minute, crystalline inclusions with a rhomboidal outline. The mean of measures of several of the more perfect ones gave a length of 0.073 mm. and a width of 0.026 mm. The thinnest are nearly colorless, but, where several overlap, the color is nearly the same as that

of the limonite-stained parts of the olivine in which they occur. All are oriented, but, because of the distorted condition of the olivine and other unfavorable factors, it is not possible to determine the relation of the inclusions to the crystallographic axes of the olivine. Since the inclusions are very thin and are entirely inclosed in the olivine, it is impossible to determine also the crystallographic properties of the inclusions themselves, on account of the interference of the surrounding mineral. However, the movement of the Becke line shows that their refractive index is less than that of the olivine. The diagonals of the rhomboidal inclusions make an angle of about 140°+. Thus the inclusions are not isometric, orthorhombic, or tetragonal. On account of their thinness, it is not possible to see whether they are true rhombohedrons, and the relation of the third axis to the other two cannot be determined. They may be, then, hexagonal, monoclinic, or triclinic, and, since Farrington[2] lists no triclinic meteoritic mineral except feldspar, they must be either monoclinic or hexagonal, or a new mineral species. Their low refractive index seems to exclude all of the monoclinic minerals listed by Farrington. Of the hexagonal minerals, some are opaque, and all the rest are excluded by their crystal forms, refractive indices, or chemical properties, except, possibly, tridymite (pseudo-hexagonal) or breunnerite.

My thanks are due to Mr. M. P. Yaeckel and Mr. R. E. S. Heineman for their attempted optical analysis of these inclusions.

REFERENCES

[1] G. P. Merrill, *Proc. U. S. Nat. Mus.*, **24**, 907, 1902.
[2] O. C. Farrington, "Meteorites," p. 117, 1915.

An Analysis of Lawrencite in the Mount Elden, Arizona, Meteorite
By JOHN DAVIS BUDDHUE

A 253-g. slice of the Mount Elden, Arizona, meteorite[1] was found to be cracking badly, on account of the effects of contained lawrencite. At the suggestion of Dr. H. H. Nininger, the slice was soaked for some time in two portions of 95% methanol. This treatment has apparently arrested the destruction of the specimen. The dark-brown solution obtained was saved, but unfortunately a brown sludge, presumably ferric hydroxide, was discarded before an analysis of the lawrencite was decided upon. The iron was precipitated repeatedly with ammonia, until nickel-free; nickel was determined with dimethylglyoxime, but chlorine was not determined. Only a doubtful trace of cobalt could be detected. The composition of the lawrencite was found to be $FeCl_2$, 91.6%; $NiCl_2$, 8.4%. The extracted material represented 1.64% of the sample of the meteorite used. This amount agrees well enough with W. A. Sloane's figure of 1.98%.[1] The nickel content of this lawrencite is considerably less than previously reported,[2] but tests showed that no trace of the nickel was retained by the iron precipitate. Perhaps a considerable quantity of the nickel was contained in the sludge which was discarded.

REFERENCES

[1] L. F. Brady, *Am. Jour. Sci.*, **21**, 173, 1931; R. E. S. Heineman, *ibid.*, **23**, 417, 1932.
[2] O. C. Farrington, "Meteorites," p. 157, 1915.

VARIABLE STARS

Variable Star Notes from the
American Association of Variable Star Observers
By LEON CAMPBELL, Recorder

The Twenty-Ninth Annual Meeting of the A.A.V.S.O.: In November, 1915, eight members of the A.A.V.S.O. gathered at the Harvard Observatory for one of their annual meetings, and by so doing inaugurated what has since become a yearly expedition. The recent meeting of October 18 and 19 thus marks the twenty-ninth in the series of the society's annual meetings and the twenty-fifth of those held consecutively at Harvard.

Of the eleven persons shown in the group photograph on that first Cambridge occasion (see POPULAR ASTRONOMY, February, 1916), only five are still living, as far as is known; and the ladies at the Observatory who received the variable star observers at that time have now Miss Cannon as their only representative in welcoming the nearly 100 persons who attend the present meetings.

On Friday evening the Association was the guest of the Bond Astronomical Club. Mr. W. F. Swann of the Eastman Kodak Company lectured on the photographic plate and its adaptation to astronomical research.

The Council met that afternoon and elected one patron, Miss Clarabel Mosman of Brookline, Massachusetts; one honorary member, Dr. Richard Prager of Cambridge, Massachusetts; and seven annual members as follows: Mr. and Mrs. Charles A. Federer, Jr., of New York, New York; Mr. George G. Hart of Henrietta, New York; The Madison Astronomical Society of Madison, Wisconsin; Mr. C. Ted Snyder of Phoenix, Arizona; Mr. Dan C. Taulman of Stephenville, Texas; and Mr. C. S. Walton of Wheatridge, Colorado.

Professor R. S. Dugan and Misses Florence Cushman and Ida Woods were recorded as having recently died.

The report of the Recorder outlined the activities of the Association for the year ending October 1, 1940, with particular reference to the gift of a 4½-inch Fitz refracting telescope for loan to active observers.

Gifts of books were acknowledged from Messrs. Anton Kovar, E. H. Jones, D. B. Pickering, and D. W. Rosebrugh, as well as numerous donations of books and pamphlets from observatories and astronomical societies. Some of the more valuable books of historical interest will be deposited for safe keeping, yet made available for reference, at the Harvard University Library.

The Association's collection of slides, now numbering well over a thousand, has been recently recatalogued and repaired, thus making them better available for loan to members for lecture purposes.

Good progress was reported by the Occultation, Nova Search, Photographic, and Auroral committees.

Messrs. E. A. Halbach, J. M. Baldwin, R. A. Seely, and D. A. Kimball were elected to the Council for a term of two years. Newly elected officers are: President, Helen Sawyer Hogg; 1st Vice President, Dirk Brouwer; 2nd Vice President, D. F. Brocchi; Secretary, D. W. Rosebrugh; Treasurer, P. W. Witherell; Recorder, Leon Campbell.

The annual total of observations numbered 45,646, somewhat less than for the

previous year, but the difference is easily accounted for by the falling off of observations from some of the foreign countries. South Africa reported 5744 observations by five observers; Italy, 1400 by Eppe Loreta; India, 1987 by two observers; Australia, 1628 by three observers; Mexico, 1144 by two observers; Japan, 891 by five observers; Canada, 825 by two observers; Germany, 416 by two observers; Belgium, 401 by de Roy; and Greece, 159 by five observers.

The observers in the United States numbered 110, with a total of 31,051 observations. Special mention was made of the coöperative plan of observing used by the Milwaukee Astronomical Society, which contributed 3108 observations by 16 observers. Four members 'of the Maine Astronomical Society contributed 5340 observations.

The papers presented were as follows:

The Changing Light Curve of Kappa Pavonis, by A. W. J. Cousins
The First American Solar Eclipse Expedition, by W. L. Holt
Transit of Mercury Observations, by F. G. Watson
Schmidt Cameras and Color Indices, by J. G. Baker
The American Amateur and Variable Stars, by W. S. Houston
The Regular Variable, TT Aquilae, by Miss V. Brenton
An Irregular Variable, TW Pegasi, by Mrs. H. L. Thomas
A Forgotten Variable, RT Muscae, by Miss P. Sullivan
A Queer Variable, S Persei, by M. Huruhata
Another Queer Variable, BF Cygni, by L. Jacchia
The October 1st Solar Eclipse Photographs, by C. A. Federer, Jr.
An Inexpensive Camera, by A. Navez
Auroral Photographs, by E. A. Halbach.

Professor D. H. Menzel gave the address of the afternoon talking on "The Coronagraph and the Harvard-Climax Station."

The interval between the morning and afternoon sessions was spent at the Oak Ridge Station where members were the luncheon guests of Dr. and Mrs. Shapley, and where an opportunity was given to inspect the new equipment, especially the Jewett 33-inch Schmidt-type telescope.

The annual banquet was held at the Hotel Continental Saturday evening. Dr. Bart J. Bok, the guest speaker, took as his subject "Astrological Problems of Today." Dr. Shapley, in his annual review of the "High Lights of Astronomy" during 1940, made particular reference to the work of Lyman Spitzer on the problem of the formation of the solar system; to J. G. Baker's ultra-Schmidt-type reflectors, J. W. Evans' monochromator, J. S. Hall's work on the spectrophotometry of the stars, and to J. M. Cuffey's study of the colors of stars in clusters. Continuing, he discussed the comets of 1940, Hubble's collection of photographs of galaxies, and Harvard's recent work on the periods of Cepheid variables near the center of our galaxy. Movie films of the Spring meeting of 1940 were shown by L. J. Boss.

The meeting adjourned to the Spring of 1941, when it will gather for its third meeting as guests of the Vassar College Observatory, Poughkeepsie, New York.

Gamma Cassiopeiae: According to observations made at the Dearborn Observatory, γ Cassiopeiae had brightened to magnitude 2.65 on October 29, 1940. This increase amounts to three-tenths of a magnitude above the average minimum value for the previous ten months.

It will be recalled that in 1936 this interesting bright variable star was found to be well above its customary magnitude—about equal to Polaris, magnitude 2.2—and that in 1937 it had gradually attained a brightness of $1^M.6$. In the latter part of 1937 the star began to decrease, somewhat rapidly at first, until early in 1938 it had faded to magnitude 2.6. Since that time it has decreased more slowly to mag-

nitude 2.95 in December, 1939, where, until very recently, it has remained at nearly constant brightness.

The remarkable spectral changes which accompanied the changes in brightness were of such a character that the recent increase in magnitude could be foreseen with some certainty. Ashbrook noted in June, 1940, that a new spectral cycle had begun. The so-called "shell" spectrum, which was strong while the star was faint, is fading rapidly, the dissipation of the material, thus, perhaps, accounting for the increase in the magnitude of the star itself.

It is worthy of note that the magnitude of γ Cassiopeiae during the years previous to 1936 was, in general, $2^M.2$; that the brightness increased by $0^M.6$ in 1936-37, then faded by $0^M.8$ in 1939-40. These changes suggest that the brightness of $2^M.2$ represents the time when normal conditions prevailed in the star, and, *per contra*, that the departures therefrom during 1936 and thereafter represent abnormal conditions.

Changing Brightness of Cunningham's Comet, 1940 *d:* With the probability that Cunningham's discovery may reach a brilliance not attained by any comet in recent years, there is now presented an excellent opportunity to observe the changes in brightness of such an object. It is well known that comets do not follow exactly the pattern laid down for them by the usual laws of changing distances from the sun and earth, but instead are subject to frequent, abnormal fluctuations in light as they approach and recede from the sun.

If observers, especially those trained in variable star observing, would attempt to ascertain the magnitude of this comet during the next few months, much valuable information could doubtless be obtained. From December 15 the comet should be visible to the unaided eye, and its magnitude could be easily estimated in terms of several nearby bright stars.

It is suggested that any observations recorded of the comet should be sent to the A.A.V.S.O. Headquarters at Harvard Observatory, Cambridge, Massachusetts, preferably at ten-day intervals. The reports should include the actual estimates and the comparison stars used, as well as the civil time in hours and minutes, and a statement of the optical aid used, if any.

Dates of Maxima of Bright Long-Period Variables: Tabulated herewith are the probable dates when some of the brightest long-period variables—those which usually attain a magnitude brighter than eighth—will be at maximum during the early months of 1941. These dates, taken from a recently compiled list of predicted maxima and minima for nearly 400 long-period variables, depend on observations communicated mainly by observers of the A.A.V.S.O., together with those from the Variable Star Section of the New Zealand Astronomical Society. Because of the peculiar behavior of R Aquarii in years past, this star requires special attention.

Design.	Name	Max. 1941 Mo.	Da.	Design.	Name	Max. 1941 Mo.	Da.
001838	R And	2	8	082405	RT Hya	2	10
021143a	W And	3	18	121418	R Crv	4	15
022000	R Cet	1	6	123160	T UMa	1	10
023133	R Tri	1	22	123307	R Vir	2	19
025050	R Hor	4	15	132422	R Hya	2	6
043263	R Ret	1	9	132706	S Vir	1	1
044349	R Pic	1	24	133633	T Cen	2	27
054920a	U Ori	1	9	140959	R Cen	2	22
070122a	R Gem	2	28	143227	R Boo	1	10

Design.	Name	Max. Mo.	1941 Da.	Design.	Name	Max. Mo.	1941 Da.
1536$54$	T Nor	2	18	1946$59$	S Pav	3	5
1632$66$	R Dra	1	16	1949$29$	RR Sgr	3	29
1650$30$	RR Sco	3	7	2044$05$	T Aqr	2	10
1702$15$	R⁴ Oph	2	26	2338$15$	R Aqr	1	14
1934$49$	R Cyg	2	18				

Observers and Observations Received during October, 1940:

Observer	Var.	Obs.	Observer	Var.	Obs.
Albrecht	29	41	Kearons, Mrs.	63	111
Baldwin	102	134	Kelly	13	25
Ball, A. R.	33	49	Livingston	51	61
Ball, J., Jr.	26	36	Loreta	243	1800
Bappu	25	68	Lovinus	22	27
Blunck	58	75	Manlin	4	15
Bouton	64	95	Mason	17	35
Brocchi	13	20	Maupomé	74	76
Buckstaff	20	145	McKeon	3	3
Callum	35	44	Moore	4	4
Campbell	2	2	Murphy	19	20
Carpenter	22	22	Neale	3	3
Cilley	53	103	Palo	17	24
Cooke	8	25	Parker	16	17
Cousins	44	150	Parks	12	24
Craig	1	1	Peltier	67	175
Dafter	4	11	Prinslow	5	5
Diedrich	19	19	Purdy	8	8
Escalante	83	97	Rosebrugh	12	109
Fernald	166	355	Ryder	13	17
Ford	3	3	Saxon	44	44
Forrester	6	9	Schmid	2	2
Gaebler	1	1	Schoenke	12	12
Gregory	64	109	Sill	80	80
Griffin	33	33	Smith	6	8
Halbach	54	54	Snyder	3	7
Harris	37	37	Stahr	14	14
Hartmann	140	201	Taulman	15	15
Heckenkamp	5	10	Topham	63	72
Hiett	14	40	Townsend	9	9
Hildom	23	29	Walton	10	13
Holt	66	77	Webb	50	51
Huffer, R. C.	12	12	Yamada	11	46
Irland	7	7	Yamasaki	20	20
Jones	79	270			
			70 Totals		5358

November 12, 1940.

Notes from Amateurs

Encke's Division in the Outer Ring of Saturn

In this short space the writer will attempt to place before the reader some observations which he hopes will be of interest. All observations were made by Hugh Johnston and the writer, using home-made reflectors of 8 inches aperture, at Des Moines, Iowa.

Encke's division in the outer ring (ring A) is not always to be seen with a telescope, however large, even in good seeing; however, it has been seen with quite small instruments at times, and under good conditions.

Four observations were made by Hugh Johnson as follows:

August 20-21, 1940, 3:00 A.M. 213×. Seeing = 8 (scale of 1-10).

"Of importance is the strong suspicion that Encke's division is visible at the ansae of the outer ring; an observation duplicated yesterday morning."

Johnson also suspected it on two other dates this year, and on October 25-26, "Almost positively confirms a delicate but sharp Encke's division." He also states that it was not usually visible to the same degree of conspicuousness at either of the ansae.

The following observations were made by the writer:

November 6-7, 1940, 8:30 P.M. Seeing = 9. 300×.

In this all but perfect seeing the ring seems to be divided into three distinct parts. At the inner circumference of the ring and extending outward perhaps one-fourth the width of the ring is a light band. A similar band is visible at the outer circumference and extending inward about one-half the width of the ring. The area between is dark, and is believed to be Encke's division.

On the following date Encke's was seen as a fine dark line.

It is hoped that this will lead other amateurs to investigate this interesting problem. The writer will also be glad to hear from other amateurs interested in the study of the planets.

FRANK VAUGHN, JR.

532 Polk Blvd., Des Moines, Iowa.

The Cleveland Astronomical Society

On November 15 at 8:00 P.M., we visited the Burrell Observatory, Baldwin-Wallace College, Berea. We were welcomed by Dr. O. L. Dustheimer, Director, with a short get-together meeting in the lecture room. This observatory is a real gem. Dedicated last June as a memorial to the great designer and engineer Edward P. Burrell it well commemorates his achievements. After looking over the building most of us gathered in the dome and endeavored to catch a glimpse of Saturn as cloud conditions permitted. Not the least pleasant part of the evening was due to Mrs. Dustheimer and her fair assistants who served cider and doughnuts at a long table set up in the transit room. Genial Dr. Dustheimer has accomplished a great deal in this section of the country with his radio talks and Monday evening public nights at the observatory. The new refracting telescope is of the latest design with an objective of 13½ inches clear aperture. Among prominent astronomers present were Dr. Dayton C. Miller and Dr. S. W. McCuskey. Those wishing to join our society should communicate with Mrs. Royce Parkin, Secretary-Treasurer, The Cleveland Astronomical Society, The Cleveland Club, Cleveland, Ohio.

DON H. JOHNSTON.

Starcrest Observatory, Collins, Ohio.

The Cleveland Star Party, August 8, 12, and 15, 1940

Early in the summer of 1939, David Dietz, the Science Editor of the Scripps-Howard Newspapers, with his offices in Cleveland, conceived the idea of putting on a "Star Party" for the public. A report of its success is contained in the April, 1940, issue of POPULAR ASTRONOMY. The three parties given in quick succession that summer were so successful that Mr. Dietz again asked the writer to assist him with a series of three more this summer. The general plan was to be the same as before: Mr. Dietz to run the publicity in his paper; and the writer to gather together all the amateurs and their telescopes hereabouts.

This year we were fortunate in being able to secure more amateurs' telescopes than before, due to the fact that the writer had had the privilege of conducting a telescope-making class at Baldwin-Wallace College in Berea, Ohio, for the last two winters. It is also the writer's custom to keep a card index of the names and addresses of all those who inquire of him concerning telescopes and their construction. This year we were able to round up twenty portable telescopes of various sizes and shapes, as follows:

All Home-made	*All Factory-made*
Four 6-inch reflectors (long focus)	One 2-inch refractor
Five 6-inch reflectors (short focus RRF)	One 2½-inch refractor
Three 8-inch reflectors (short focus RRF)	Two 3-inch refractors
One 10-inch reflector (short focus RRF)	One 4-inch refractor
	One 4½-inch refractor
	One 6-inch refractor

We were unfortunate this year in having no astronomical event of any importance for a "build-up." It will be remembered that in the summer of 1939 the planet Mars was much talked of, due to its close approach. Great public interest was whipped up over this planet. The summer of 1940 was devoid of anything startling at all. Even the bright planets were morning stars, so we were forced to choose the moon as the object of our "Star Party." As a matter of fact, the moon makes a fine object for such a show. In 1939 the folks all wanted to look at Mars. They thought they would see the canals, people, and the like. Disappointment was written on every face. But the moon was different. The moon is really one of the finest objects that can be shown to a group such as we had. We therefore decided to have the first "Party" on August 8, with the moon at first quarter.

Mr. Dietz played up the moon in great shape in his paper. He guaranteed that when he got through, the public would be moon conscious. They would wonder why they had not thought of looking into the situation long ago. And, of course, even our small amateurs' telescopes were able to perform what we preached.

During the 1939 "Party" we had the experience of handling immense crowds. Nearly 8000 people attended each of the three gatherings. We had telescopes knocked over, and people grabbed the eyepieces or tripped over the counter-weights in their anxiety. This year, we arranged our affair differently. We made a deal with the police department to provide us with staunch "safety zone" posts, and we set them up at intervals with stout ropes from post to post, in such a manner that long lanes were formed—as many lanes as there were telescopes. In the middle of each lane, we placed an instrument, and at the entrance, we placed two members of the staff, to allow only one person into the lane at a time. There was therefore no pushing or crowding, and hence no wrecked telescopes. One smart fellow even brought a red lantern and hung it on his counter-weight. The people moved past steadily and evenly, had a good long look, and moved away again. If they wished to ask a question, they were referred to another member of the staff, who did his best for them. Two members acted as guards in each lane. One operated the telescope, and one was stationed at the instrument to answer questions, with a few "spares" in reserve. Each telescope owner was responsible for his own "crew."

Long before dark the people started to arrive. The telescope owners were there early, for we could start on the moon quite a while before dark. The lines moved smoothly and everyone was happy.

We were fortunate to have with us this year two professional men, who made the "Star Party" a real success. Every fifteen minutes Dr. O. L. Dustheimer, Pro-

fessor of Astronomy at Baldwin-Wallace College, Berea, Ohio, would take the microphone and give a popular lecture on the moon over the loud speaker system we had installed in the middle of the park. Then in turn would come Dr. J. J. Nassau, Professor of Astronomy at Case School of Applied Science, Cleveland, Ohio, with an explanation of what was being seen. Dr. Nassau also kept the people busy while waiting their turn at a telescope, by putting on an impromptu question and answer contest on astronomy. This went over big. Of course, David Dietz would take his turn at the microphone too when things slowed up a bit. He was always there when we needed him, trying to make the party a bigger and better one.

We were very much surprised to have several other professional men attend. They were accordingly introduced over the microphone. Who should arrive but Dr. Dayton C. Miller, the famous physicist. The newspaper photographers nearly shot him to pieces when he was discovered looking intently through someone's small 6-inch telescope.

So the party went. The usual peanut vendors appeared out of space. Ice cream peddlers had to be continuously hushed up. We started early in the evening, so we were able to finish early. By ten thirty nearly 3500 people had taken at least one look, and we know for sure that many hundreds went from one telescope to another to compare. Some said "Aw! That telescope ain't so good," or "Yuh otta take a look through that 'un." Frequently was heard, "Goodness, I thought you looked in the end of a telescope," when some soul was told to try looking into the side of a reflector. The long reflectors were a nuisance. No ladders to stand on. So the short people were advised to line up before a short reflector. "Short for short, long for long. You can't get a look if you get this wrong" we would shout. Soon all caught on, or boxes were provided to stand on. Grandpas, papas, and babies all had a look at the moon. Clouds interfered at times, and all the instruments had to close down. It was then that we needed Dr. Nassau and Dr. Dustheimer and Mr. Dietz to put on some kind of a show on the microphone to keep the people interested until the old moon came out again. A good time was had by all.

A few days later, we put the show on again in an east side park. Another few days, and we were again at a north side park. We had about 3500 people out each time. Next year we hope to do it again three times, and we hope to have three more popular expressions of the interest the common people take in the subject of astronomy.

JAMES L. RUSSELL.

General Notes

Honorary Member of A.A.V.S.O.

At its Thirtieth Annual Meeting held at Harvard College Observatory, Cambridge, Massachusetts on October 19, 1940, the American Association of Variable Star Observers elected Dr. Richard Prager to Honorary Membership, upon motion of Dr. Harlow Shapley, Director of the Harvard Observatory.

Dr. Prager is at present doing bibliographical research work on variable stars at Harvard and has just completed a compilation of data on thirty-six hundred recently discovered variable stars in the constellations Ophiuchus-Orion through Vulpecula.

For many years Dr. Prager was editor of the *Katalog und Ephemeriden Ver-*

änderlicher Sterne published in Berlin. Before leaving Germany he published two volumes of a "Geschichte und Literatur der Lichtwechsels der Veränderlichen Sterne," but was unable to complete the concluding volume. He is one of the leading variable star astronomers of the world especially in the bibliographical field, and the American Association of Variable Star Observers is happy to elect him an Honorary Member.

Cablegram Deciphered

The cryptic message received by the American Astronomical Society at its meeting at Wellesley College last September, mentioned on page 402 of the October issue, has been interpreted. Mr. F. M. Garland, president of the Amateur Astronomers Association of Pittsburgh, by using a code adopted by a firm whose business interests lie in the tropics, gives the following meaning to the message:

Being = Everybody is well
Quirk = Prospects good
Biped = Hope all is going well with you.

Anyone who is acquainted with Dr. Farnsworth and Dr. Smiley, the senders, can readily accept this interpretation since it exhibits the optimism and good cheer which are characteristics of these persons.

The Sixty-Fifth Meeting of the American Astronomical Society, in affiliation with the American Association for the Advancement of Science, will be held at the Franklin Institute and University of Pennsylvania, Philadelphia, December 29-31, 1940. The tentative program is announced by Dean B. McLaughlin as follows:

Sunday, December 29—
  8:00 P.M. Council meeting.
Monday, December 30—
  9:00 A.M. Official welcome to the Franklin Institute by Dr. Henry Butler Allen, Secretary and Director. Session for papers.
  2:00 P.M. Session for papers.
  3:30 P.M. Official welcome to the University of Pennsylvania.
  4:30 P.M. Tea at Flower Observatory, followed by visit to Cook Observatory.
  8:30 P.M. Demonstration, Fels Planetarium.
  9:30 P.M. Refreshments, (compliments of the Rittenhouse Astronomical Society), inspection of astronomical section of the Museum of the Franklin Institute; Informal gab-fest.
Tuesday, December 31—
  9:00 A.M. Council meeting.
  10:00 A.M. Session for papers.
  12:30 P.M. Photograph.
  2:00 P.M. Session for papers.
  7:00 P.M. Society dinner and exhibition of old astronomical books of the late Gustavus Wynne Cook.

The sessions for papers, as well as the Society dinner, will be held at the Franklin Institute. For the visit to Flower Observatory, bus transportation will be furnished for those who do not have their cars or who cannot be accommodated in available private cars. The Fels Planetarium is in the Franklin Institute building.

According to plans now being formulated, it is likely that a portion of the meeting will be given over to a symposium on a topic of general and timely interest.

The Rittenhouse Astronomical Society designated its meeting held in the Lecture Hall of the Franklin Institute on Friday, November 15, as Flower Observatory Night. The speakers were Dr. Samuel G. Barton, on the topic, "The

Orbits of Comets," and Dr. Charles P. Olivier, on the topic, "The Physical Nature of Comets."

Correction.—On page 481 of the preceding issue, that of November, 1940, line 10, the 117° is to be understood as the heliocentric longitude of Jupiter and Saturn in conjunction, not the longitude of the sun as there stated. ED.

Book Reviews

The Soul of the Universe, by Gustaf Strömberg. (David McKay Company, Washington Square, Philadelphia, Pennsylvania. $2.00.)

Sometimes the title of a book furnishes very little indication as to the contents of the book. That is not the case with the volume at hand. In this title the author has brought together what might be termed the central word in philosophy and the central word in science. Formerly the word *universe* was regarded as belonging more particularly to astronomical science, but it is now generally known, even by those who are not scientists professionally, that the universe extends as far in the direction of the minute as in the direction of the immense. With this understanding of the word one's first impression is that here is a volume whose purpose is the interrelating of philosophy and science. This is, indeed, correct.

Such an undertaking requires more than a superficial acquaintance, a reading knowledge as it were, with science. One must have done actual work in that field. It requires also a philosophical bent, an appreciation of the abstract as well as of the concrete. These qualifications are possessed in a high degree by the author. This is clearly indicated by a comment by Professor Albert Einstein concerning the book. He says, "What especially impressed me was the successful attempt to isolate the essential facts from the bewildering array of discovered data and the presentation of them in such a way that the problem of the unity of our knowledge becomes a rational one." He says further, "Very few men could of their own knowledge present the material as clearly and concisely as he has succeeded in doing."

The discussion is divided into twelve chapters, as follows: 1. Space, 2. Time, 3, Matter, 4. Gravitational and Electrical Fields, 5. Living Matter and Organisms, 6. The Mechanical Aspect of Life, 7. Heredity and Genes, 8. The Origin and Development of Life on Earth, 9. Mind and Matter, 10. The Development of the Human Mind, 11. The Soul, 12. Retrospection. Thus the reader is conducted from the abstract concepts of space and time, through the mechanical and physical aspects of existence, to the purposeful and ultimate realities of mind and soul.

It is, of course, impossible to epitomize a volume of such depth and scope. To omit one chapter or even one page is to lose the thread of the thought and the full significance of the conclusions. However, one may, perhaps, get an idea of the author's point of view from the final paragraph of the brief *Retrospect*. After a sketchy yet also a succinct review of the contents of the volume, he concludes thus, "During our travels we have come very far from where we started. But there is no turning back in this kind of journey. On and on we must sail through eternity, learning new lessons and performing new missions, all the time preparing ourselves for bigger and bigger tasks in the service of the *Inscrutable One*.

"This seems to be our Destiny."

The volume is to be highly recommended to the general reader. At no time does the scientific discussion become technical and at no time does the philosophical presentation become didactic. Facts are clearly stated, inferences are fairly made, and conclusions are convincingly reached.

The reviewer can testify to having received much pleasure and satisfaction and instruction in the reading of this volume, and he prizes it as a part of his library.

C. H. G.

The Philosophy of Physical Science, by Sir Arthur Eddington. (Macmillan Company, 1939. Price $2.50.)

Sir Arthur Eddington has again given us a book which supplies abundant food for deep thought. It may be regarded as a sequel to his "The Nature of the Physical World" and "New Pathways in Science," published in 1928 and 1935, respectively, which in popular form gave us glimpses from the new world which science has revealed to man. The new book is of a more philosophical nature and goes deeply into the epistemology of modern science and contains an analysis of the kind of knowledge physical science is supposed to represent.

At present there is an authoritative body of opinion which decides what is and what is not accepted as present-day physics. This is the basis, not only of the philosophy of scientists, but also of the philosophy of science. This basis is implicit in the methods by which science is advanced and in the procedure which scientists adopt when establishing what they call the facts of nature. The Relativity Theory and the Quantum Theory which, since they embrace a vast body of observed phenomena and facts and seem to go deepest into the nature of things are, of course, the centers of attention.

In the first eight chapters of his book Eddington advocates a philosophy which he calls "Selective Subjectivism." Much of the controversy among scientists and philosophers is due to the fact that they do not always clearly define what they are talking about. We all deal with selected knowledge, depending upon our sense organs and our mental equipment. Physicists devote their studies to a particular class of data, most of which can be expressed in terms of measurements of lengths and of time intervals, and the generalizations they make are supposed to be verifiable by appeal to measurements. (Colors, pain, and joy do not belong to the field of physics but they are not therefore less real.) The epistemologist is supposed to watch the observers and particularly the "good" observers, those whose activities follow a conventional plan of procedure. He is interested in this plan and in the working of the observer's mind in order to find out how much of the observed body of facts can be regarded as inherent in nature and how much is due to the particular plan of observing and to the idiosyncrasy of the observer's mind. "We learn the observer's plan by listening to his own account of it and cross-questioning him."

Eddington speaks about *"a priori* knowledge." We have a knowledge of the physical universe prior to any actual observation of it. It is prior to the carrying out of observations, but not prior to the development of a plan of observation. This seems to be the cardinal point in Eddington's thesis and is liable to cause much controversy among philosophers. The universe of physics is, at least partly, subjective. As Eddington later develops his epistemology he finds it *wholly subjective*. The universe is in our mind and the picture we have of it depends entirely on our mental equipment.

As a striking example Eddington cites the big number 16×10^{78}, which is sup-

posed to represent the number of protons in the universe. If there were anything which could be expected to be independent of the human mind it would be the total amount of matter in the universe, since it does not seem greatly to affect our daily life or the structure of our mind. But this number represents a "quadruple existence symbol," and its value depends only upon the four dimensional character of space-time. Its exact value is $136 \times 2^{256} = 1.575 \times 10^{79}$. Eddington gives this number with all its 80 figures. Nobody can prove it is not right, for the protons and electrons in the universe can not be counted even in principle. But there is no doubt that it has a deep cosmological meaning. A clever man, knowing how the human brain works, could have told us all about it without making any observations at all.

Far be it from the reviewer to attempt to criticize a work of this profound type. I only want to call attention to the possibility that the epistemologist himself may not be infallible and to the fact that he has the same kind of mind as the observer. Personally I think it is very important that we realize the fact that our mind puts its imprints on our observational data to a much greater extent than we usually realize. Further I believe that our mind and our brain are themselves products of Cosmos. It does not then seem so surprising that the attributes of Cosmos are reflected in the human mind. When we look into our own mind we find —Cosmos.

<div align="right">Gustaf Strömberg.</div>

Magnitudes and Coördinates of Comparison Stars In 52 Regions of Variable Stars and Magnitudes of 284 Variables, by Charles P. Olivier and Others. (*Publications of the University of Pennsylvania, Astronomical Series,* Vol. V, Part III. pp. 66. University of Pennsylvania Press, Philadelphia, 1940. $1.50.)

This is the first publication of the Flower Observatory which deals with results of the study of Variable Stars. Table I contains 990 observations of 231 long-period stars taken from the program of the A.A.V.S.O., Table II, 2486 observations of 53 other stars. These were selected partly from lists of recently discovered variables of which little or nothing definitive was known, partly from older stars with irregular light variations and small amplitudes. For each field the magnitudes of the comparison stars were carefully determined, both by repeated observations of the step values and by measuring with a wedge-photometer. Nearly all of the observations were made with the 18-inch refractor. The positions of the stars are given for the equinox of 1950 which does not seem very appropriate. It would be desirable to preserve the equinox of 1900 for several years more, and then to make a transition immediately to the equinox of 2000.0 for all star catalogues, especially those of variable stars, nebulae, spectra, and such like, where the positions are given approximately. In this way we should be able to save a vast amount of computing work for the present and future generations.

<div align="right">R. Prager.</div>

POPULAR ASTRONOMY
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DECEMBER, 1940

POPULAR

ASTRONOMY

A REVIEW OF ASTRONOMY AND ALLIED SCIENCES

Founded by W. W. PAYNE

CURVIN H. GINGRICH
Editor

VOL. XLVIII

1940

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28½" Cassegrain Newtonian Reflector, electric drive, clamps, electric slow motions in right ascension and declination, circles in right ascension and declination; with Spectrograph and Double Slide Plateholder. Designed and constructed for the Cook Observatory, by

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